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ILLINOIS TECHNOGRAPH

DECEMBER 1953

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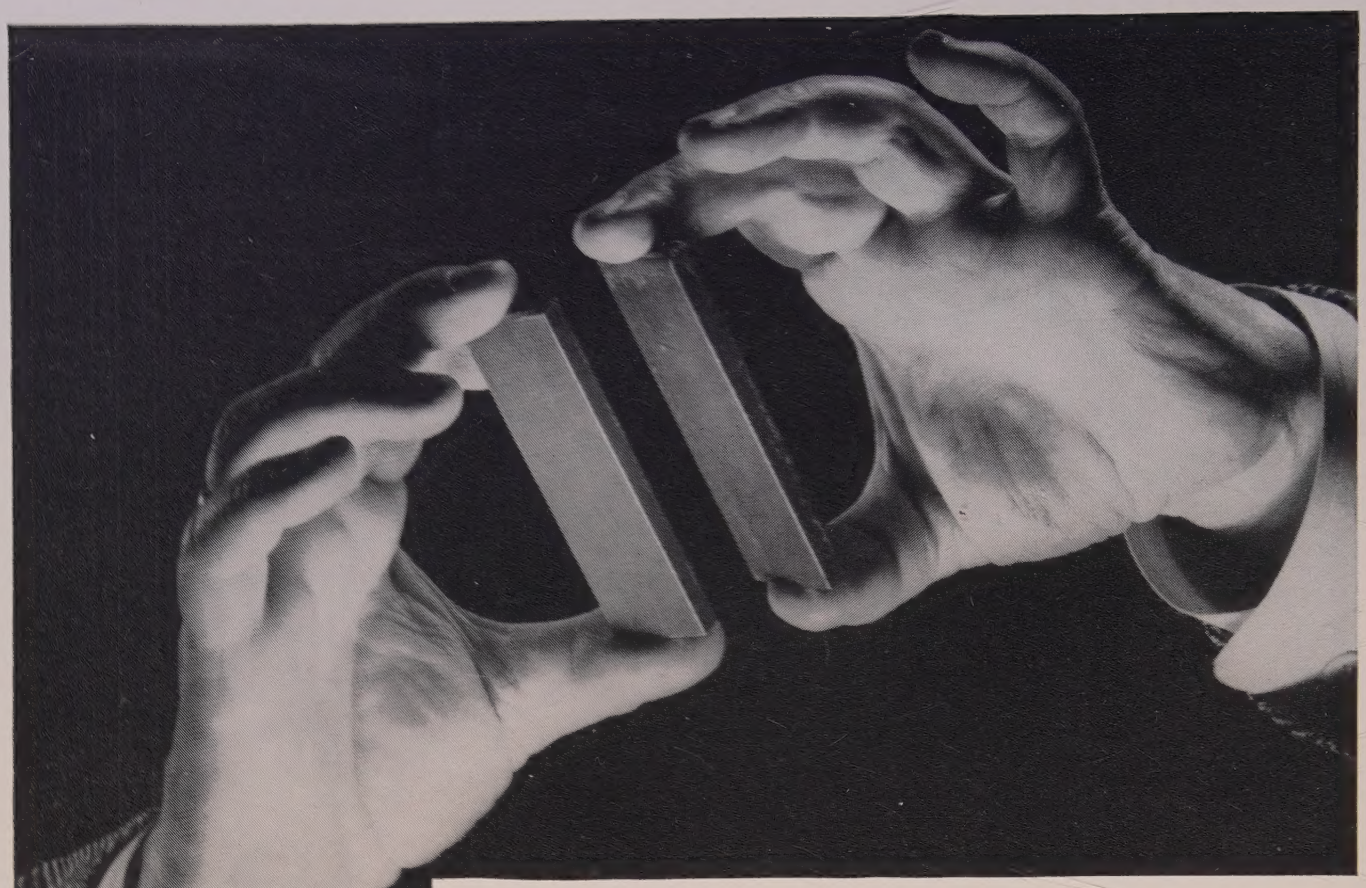

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THE ILLINOIS TECHNOGRAPH

volume 69 **number 3**

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our cover

Engineering through the years—prehistoric man using brute force to move large objects—next the Egyptians rolling large boulders on rollers—the ancients observing a bird in flight and wishing they could do the same.—James Watt observing the force of steam on a kettle cover—the Bikini atomic test—a hydroelectric power unit—the Wright brothers—Leonardo da Vinci and his sketches of a flying machine—a Viking sounding missile. Today's engineer at his drawing board is looking ahead to bigger things. (Cover by Dave Templeton)

our frontispiece

The frontispiece shows the boom of the dragline used for stripping the overburden from the vein of coal at the Harmattin mine near Danville, Ill. The 180 foot boom has a dumping radius of 174 feet, and it carries a bucket with a capacity of 25 cubic yards. The picture was taken by Assoc. Prof. C. Dale Greffe of the M.E. Department and it has had moderate success as a salon print in National and International Photographic Salons.

TIME COMPRESSOR MACHINE

by Charles Runyan, E.E. '57

Years may now be added to your life by the use of a newly invented "Time Compressor." It is no longer a figment of imagination but a reality. The Time compressor has been invented here at the University of Illinois, by Prof. Grant Fairbanks, director of the Speech Research Laboratory; Dean William L. Everett of the College of Engineering; and Robert P. Jaeger, electronics technician, formerly at the University and now with a commercial laboratory.

According to Prof. Fairbanks, the machine will actually add effective years to our lives. For example in a normal seventy year span with 15 to 20 per cent compression, five years of effective time would be added to our lives. In the realm of Education during a normal eight semesters work, one semester could be saved.

The Time Compressor was developed from the well known scientific fact that the ear responds quicker than the mouth and can understand a great deal faster than we can speak. Since the human speech organs can't be speeded up without loss of diction and comprehension, a device called the Time Compressor was invented. It simply takes speech or music and compresses it without the loss of a single syllable or note, or without changing the frequency or pitch. In practical effect the machine actually will shorten a 60 minute speech to 50 minutes without detection. Compressions of 10 percent or even 20 percent pass unnoticed. Even compressions as high as 50 percent does not destroy understanding of speech. Music put through the Time Compressor has its tempo increased, but the pitch and clarity of individual notes are unchanged.

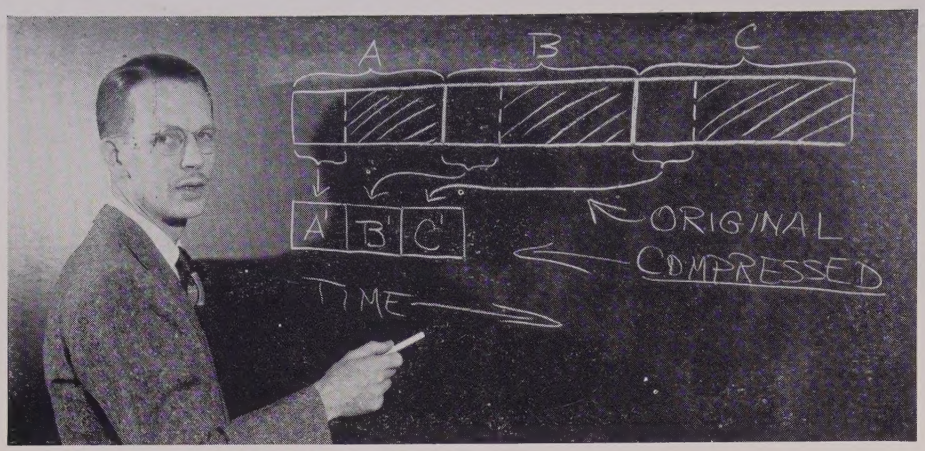
Possible Uses of Time Compressor

Although Prof. Fairbanks was reluctant to predict possible uses of the machine, some that have been submitted are as follows: radio programs "tailored" to fit broadcast time; "talking books" for the blind presenting information understandably at nearly twice the present speed; unbelievable rapidity and precision in music, actually offering new musical experiences; conferences, conversations, airport control direction, etc., recorded on less tape and reviewed in much less time; faster presentation of facts in broadcasts beamed behind the iron curtain, and therefore less danger to listeners; faster reports over long distance telephone or radio; new production opportunities for motion pictures and television; and new techniques for teaching. There are undoubtedly a hundred or more other possible uses for the Time Compressor.

How Time Compressor Works

As has been said before much of what we speak can be classified as redundant and can be eliminated without affecting understanding. This is the principle of the Time compressor. It merely removes

Prof. Grant Fairbanks (left) and Dean W. L. Everitt with the "time compressor" invented at the University of Illinois. (U. of I. Newsphoto)



Prof. Grant Fairbanks demonstrates time compression by the use of phenomes. The "time compressor" was invented at the University of Illinois.

this oral redundancy mechanically. During the experimenting stage, Prof. Fairbanks, after working out the theoretical principles, made a tape recording and cut it into small bits. Each of these bits of tape covered a few hundredths of a second of the recording time. Then he threw away every other one and pasted the remaining ones back together. The result was a little rough but understandable even though half of the sound had been omitted. Then the Time Compressor was devised to discard portions of the incoming sound automatically and to push the retained portions together smoothly without changing the pitch of the resulting signal. This is accomplished without actually cutting the tape. A simple way to look at the machine is this: if you removed every other board from a fence, and pushed the remaining boards close together, you would have a compressed fence. If a sign in large letters had been painted on the fence, you could still read the compressed sign, and it would be in the original color and shape.

The mechanism involves a continuous loop of recording tape on which sound is temporarily stored, and a set of four pickup heads in a revolving drum around which the tape makes a right-angle turn. The pickups are arranged like the spokes of a wheel. Only one touches the tape at a time, and as one moves off another, one comes in contact. As far as the outgoing sound is concerned, the playback is continuous, but actually that part of the original sound which was between the two contacts and untouched by them is left out. In order for this to be accomplished, the tape and drum are run at different speeds and if varied independently any degree of compression can be obtained. If the drum is rotated opposite to that of the tape, each pickup will overlap and the bit of sound there will be repeated and the machine becomes a "time expander."

Theory of Time Compression and Expansion

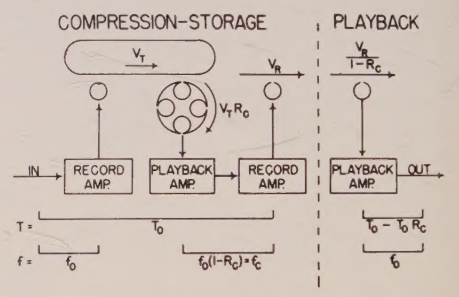
For purposes of explanation assume two different sounds, A and B, of equal duration as shown in Fig. 1. A′ and B′ are the same as sounds A and B, but shorter in duration, but still adequate for perception. A′and B′ are extracted from A and B and abutted in time as shown without discontinuity, and the redundant sound A-A′ and B-B′ are discarded. If the sounds A′ and B′ are reproduced, the time will be shorter than the original A and B but will be just as perceptible.

In the case of expansion, assume that sounds A and B are caused to be repeated, as in the middle portion. If A, A, B, B is reproduced the time will be longer and the auditory effect should be that of prolongation of A and B.

Finally, assume that A and B are first compressed to A′ and B′ and then expanded to A′ A′ B′ B′ as shown at the bottom of Fig. 1. Here the original time for A and B has been restored. A and B have been reconstructed from A′ and B′.

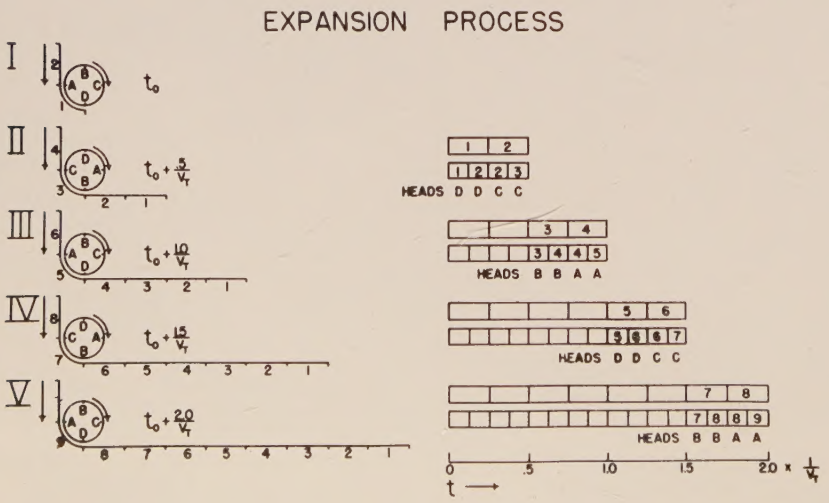
Compression Process

The time compression depends on the revolving head assembly and the four lettered playback heads shown in Fig. 2. The tape passes over the drum and is in contact with 1/4 of its circumference, or a distance equal to the peripheral distance between any two adjacent playback heads. The tape is retained by flanges around the drum periphery. Tape direction is constantly counter-lockwise. In the compression application the direction of drum rotation is also counter-clockwise. Under load the top tape velocity is approximately 190 in./sec. The top peripheral drum velocity is about 225 in./sec.



For purposes of explanation the tape is divided into numbered segments, each equal to the distance between heads. The relative positions of tape and heads are shown at representative times. The diagram shows 50% time compression as an example.

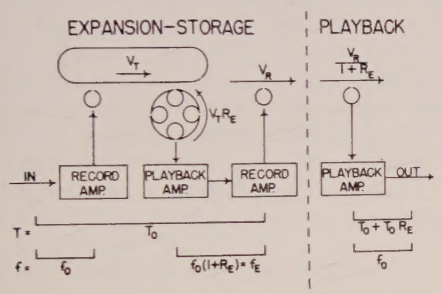
In part I, segment 1 is shown at t_o when it first comes into contact with the drum. At this time it is intercepted by head A, which is moving in the same direction. If the drum were stationary, reproduction would be one-for-one. If its velocity were equal to the tape, no signal would be reproduced. Between times I and II, however, head A moves through 1/4 of a revolution. During the same interval tape segments 1 and 2 pass through the 9 o'clock point where head A was at t_o. As a result, head A reproduces segment 1 during that interval. The effective tape velocity is V_t-V_h. In the example diagrammed V_h equals



$V_t/2$ which equals the effective velocity. Therefore, the frequencies of segment 1 as reproduced by head A are divided by 2.

At time II head A is at 6 o'clock and head B is at 9 o'clock, while segment 2 lies between them in contact with the drum. Head A is about to leave the drum, while head B is about to begin reproducing segment 2. Although there is no discontinuity, segment 2 is not reproduced by any head. The remaining diagrams show how the process continues, the odd numbered segments being reproduced at reduced frequency and the even numbered segments being discarded. It is evident that various durations of either reproduced or discarded segments can be realized by varying the absolute and relative velocities of tape and head, and that a range of sampling frequencies and compression ratios can thus be produced.

The output of the device with respect to time is diagramed at the right of Fig. 1. Between times I and II, for example, segment 1 is reproduced by head A in the time necessary for both segments 1 and 2 to pass a point. Head B then

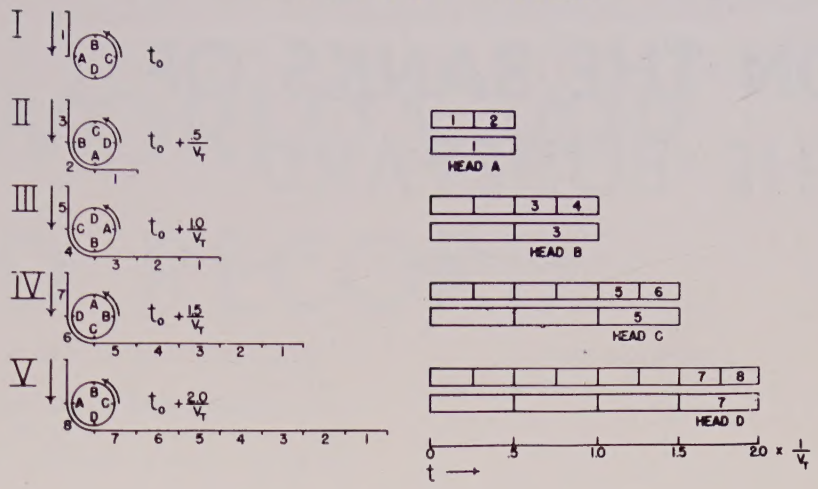


reproduces segment 3, etc. The final yield of segments 1, 3, 5, and 7. When these segments are stored at a given speed and then reproduced at an appropriately higher speed, their original frequencies are restored and the elapsed time is shortened.

With respect to duration the odd-numbered segments are termed sampling intervals; the even numbered segments discard intervals. The reciprocal of their summed durations is the sampling frequency. The discard interval divided by the sum of the two intervals will be termed the compression precentage. Since sampling is periodic the ratio applies also to the total message time, and describes the percentage by which that total time has been reduced. Fig. 4 shows the method of time compression.

Expansion Process

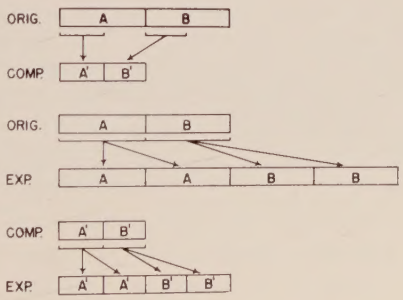
Fig. 3 shows a similar diagram for expansion. Here the drum bearing the playback heads revolves in a direction opposite to that of the tape. The example shows the condition when these velocities are equal. The effective velocity is equal to their sum.



At T_o, shown at I, segment 1 is in contact with the drum between heads A and D. During the next interval head D, as it moves from 6 o'clock to 9 o'clock, will reproduce both segments 1 and 2 and then leave the tape. At that time it will be replaced by head C, which has moved to the 6 o'clock position to intercept the tape at the beginning of segment 2, and which will reproduce segments 2 and 3 during its sweep. The result, shown at the right, is that between times I and II, while segments 1 and 2 are passing the 6 o'clock point, segments 1,2,2,3 are reproduced.

Since the effective tape velocity has been increased by the opposite movement of head and tape, frequency multiplication has been incurred. The original frequencies are restored by reproducing the processed message in an appropriately longer time. The amount of time thus added divided by the original time is the expansion percentage. In the diagram this equals 100%. Fig. 5 shows a block diagram of time expansion.

The machine has another important possibility. Instead of compressing time it can be used to compress the tones of a voice, and then to expand them back to original understandability. This is an almost instantaneous process which may



permit a telephone or radio circuit to carry many conversations where one now is carried. This problem of "bandwidth reduction" has interested engineers for a long time. They have found various ways of making circuits do multiple duty, and now the compressor may offer another possibility of carrying more messages without building more expensive transmission facilities.

The University Foundation has applied for a patent on the "time compressor" and will soon grant permission to companies to come to the U. of I and make copies for use in finding out its commercial possibilities.

Husband in movie: Can you see, dear?

Wife: Yes.

Hubby: Is there a draft on you?

Wife: No.

Husband: Is your seat comfortable?

Wife: Yes.

Husband: Let's change seats.

* * *

Mark Twain once debated polygamy with a Mormon. The Mormon claimed polygamy was perfectly moral and defied Mark to cite any passage of Scripture which forbade it.

"Well," said Twain, "how about that passage that tells us no man can serve two masters?"

* * *

The local reporter was interviewing the grandfather of a Hollywood star.

"Does Bill ever come back to the old farm since he's such a big shot in the movies?" he asked.

"Every summer," said the old man proudly, "Every one of the five summers he's been away."

"And did he bring his wife with him?"

"Every time," replied Grandpa, "and they was five as purty girls as you ever laid eyes on."

* * *

Some of the most profitable fiction in the world has been composed by college students writing home for money.

* * *

The best gifts are always tied up with the heartstrings.

ON THE BANKS OF THE BONEYARD

by Alan C. England, E. Physics '54

Future Salaries

In the October issue of the *Iowa Engineer*, Mr. M. M. Boring, manager of the General Electric Company Technical Personell Divisions, gave some facts of interest to future engineers. He states that the average engineer will acquire a position paying $350 per month upon graduation and will be making $830 per month in fifteen to twenty years. Most engineers will not have to worry about being fired in case of a depression. Doctors have the highest salaries in general with engineers and scientists next followed by dentists and lawyers. The bright side of this story is that the doctor has to spend twelve years in school to the engineers four, must make a large investment in equipment, has a shorter life expectance, and a shorter professional life. The need for engineers this year and in future years far exceeds the number graduating. Only about 21,000 will graduate this year while the demand is close to twice that figure.

Engineering Council

At the October 15 meeting of the Engineering Council several positions were filled for major engineering activities in the coming year.

George Hunt was named chairman of the Engineering Open House committee for 1954 and Glenn Zieman was named chairman of St. Pat's Ball. The possibility that the Souder-Finnegan Orchestra might be hired for St. Pat's Ball was suggested.

A booklet on engineering societies and fraternities was viewed by council members for the first time. This booklet was compiled by the Council.

Apologies to J. Kilmer

Recently, in the back of an English Literature book, the following poem was found. It had evidently been written by a frustrated engineer.

Slide rules

I think that I shall never fool,
A gadget handy as a slide rule.
A rule that may be found all year
On the hip of any engineer.
A rule whose indicator is pressed
'Tween the thumbs of one slovenly dressed.
A rule, though used all the day,
That never seems to be in the way.
Poems are made by fools like me,
But slide rules are made only by K and E.

The Boneyard

"By the shores of Alma Mater,
By the shining Boneyard Water,
Stood the wigwam of Illiniwek. . . ."

Our humble apologies to Henry Wadsworth Longfellow for desecrating his work so, but this will serve as an introduction for the freshman to one of the members of the Illini's household of sundry traditions and campus spots—the Boneyard.

The Boneyard, a tributary to a tributary of the Wabash River, achieved its mysterious title when the earliest settlers to Illinois territory came upon it so many years ago. Apparently a group of animals (or maybe despondent students) huddled in a hollow of the bank for shelter (or maybe for a beer party). Anyway, regardless of their origin, they died leaving only a decaying pile of old bones and carrion. The early settlers (incidentally, now history professors) capitalized on the opportunity to name the picturesque creek the "boneyard." Since then it has been nicknamed several times, and one president of the university even tried to have it officially titled "Silver Creek," but through the years just one name has survived the endless cycles of matriculation and graduation at the old State U.

We regret having to construct the epilogue on a sad note, but it is our reluctant duty to report that the romantic Boneyard has degenerated into a melting pot for all the commercial garbage disposal and sewage systems in Champaign-Urbana. Where "Silver Creek" may once have been apropos, "Filthy Firth" is now more suitable. However, once a tradition, always a tradition, and the Boneyard is a permanent fixture in Illini lore.

Chemists Take Note

The following discourse was found last week in one of the dim basement corners of Noyes Lab.

Ten Commandments for Chemists

1) I am the word, thy chemistry text—memorize me.
2) Thou shalt not take the name of thy lab. instructor in vain.
3) Remember the laboratory to keep it spotless.
4) Honor thy lab partner's answers.
5) Thou shalt not spit into thy neighbors unknown.
6) Thou shalt not pencil titrate.
7) Thou shalt not buy thy end product.
8) Thou shalt not bear false answers to thy lab instructor.
9) Thy shalt not covet thy laboratory reagents.
10) Thy shalt not covet thy neighbors beakers, nor his test tubes, nor his Dewar flasks, nor anything that is thy neighbors.

Kind words are short to speak, but their echoes are endless.

* * *

There is no such thing as a big job. Any job, regardless of size, can be broken down into small jobs, which, when done, complete the large job.

* * *

There's a rumor going around that the government is considering issuing this directive: Anything that moves, control it. If you can't control it, tax it. If you can't tax it, give it a billion dollars.

* * *

"How is it, sir, you can make such a substantial reduction in the price of your apples for your friends, and still make such enormous profits on them?"

"Well, you see it's this way. I knock off two dollars a barrel because he's a friend of mine, and then I knock two bushels off the barrel because I'm a friend of his."

* * *

In matters of romance most girls hate a quitter—and also a beginner.

* * *

At most burlesque shows, if the girls' clothes don't drop off, the attendance does.

* * *

All the average man wants in a woman are the bare necessities.

* * *

A gigolo is a man who loves his work and vice versa.

* * *

Or as Mama Gnu said to Papa Gnu: "Bud, I've got gnus for you."

* * *

Steward on an Ocean Liner: "Your lunch will be up in a minute, Mr. Jones."

Seasick passenger: "So will my breakfast."

NEW WORLD'S AIR SPEED RECORD

by Howie Hadler, Ag. E. '55

Only fifty years ago, the Wright brothers completed the first successful flight with an airplane. This achievement in the science of flight seems very small today compared to present standards of flight. This first successful airplane was very crude, and the first flight lasted for only a few short seconds and extended over a very short distance. Today, only fifty years since that first successful flight, air trips of thousands of miles over a period of many hours are everyday occurrences. And the speeds of present day aircraft compared to those of the Wright brothers craft make their efforts seem somewhat insignificant.

On Thursday, October 29, the Air Force reclaimed the world's speed record for its new North American F-100 Super Sabre with one searing pass over the 15 kilometer course of 767 miles per hour and an average speed of 754.98 mph.

Lt. Col. F. K. (Pete) Everet, 33, Chief of the Flight Test Operations Laboratory at the Research and Development Command's Edwards Air Force Base, California, roared across the nearly nine mile course in runs of 767.276 and 732.684 mph. The course extended over California's Salton Sea.

Official National Aeronautic Assn. Timer Bertrand Rhine of Los Angeles, said the mark would be submitted as a new world's speed record. He said under Federation Aeronautique International rules the fastest average speed for either the 15 or 3 kilometer course is recognized as the top official world's mark. The FAI is the international body which regulates all air speed records.

The previous world record was set by a Navy Douglas F4D Skyray over a three kilometer course at a speed of 753.4 miles per hour. Colonel Everest flew nearly 18 miles in setting the new mark over the 15 kilometer course as compared to a total of 7.2 miles flown for the three kilometer record.

The top speed of 707.889 miles per hour for a 15 kilometer course was set September 1 at the National Aircraft Show in Dayton, Ohio, by Air Force Capt. Harold (Tom) Collins in a North American F-86D Sabre Jet.

"This 15 kilometer course is a tough one to fly because at least half of it is over water and it is difficult to pick out landmarks," the veteran test pilot declared. "It's much harder to hold a steady course for such a long distance."

Colonel Everest previously had flown the F-100 over a nearby three kilometer course at an average speed of 757 miles per hour.

Billowing black smoke marked each end of the course and the shoreline at the north end of the site to guide Colonel Everest in his runs. Official timing of the run was with a Speed Graphic Pacemaker camera with Polaroid Land Backs and an electronic counter chronograph.

Air Force Lt. Col. F. K. (Pete) Everest, 33, piloted the F-100 to a new world's record of 754.98 mph. (Photos courtesy North American Aviation, Inc.)

The North American F-100 which hit 767 mph. on one pass and averaged 754.98 over a 15 kilometer course at California's Salton Sea.

Pulling up after his first pass within a few minutes after takeoff from El Centro Naval Air Station, Colonel Everest made a sweeping turn and headed his plane toward the course. "I'm going to kick it in the tail," he radioed. Seconds later the needle nose of the F-100 flashed across the finish line.

Although racing rules permit the 15 kilometer course to be run at any altitude Colonel Everest held the F-100 within 100 feet of the ground on both passes.

The F-100 is the Air Force's first jet fighter capable of breaking through the sound barrier in level flight at altitudes where it will fight.

The Super Sabre is powered by a Pratt and Whitney J-57-7 turbojet engine with afterburner. It is 45 feet long, 14 feet high and has a wing span of 36 feet. Its service ceiling is above 50,000 feet with a combat radius of more than 500 nautical miles.

Colonel Everest is a World War II ace and has more than 4500 hours of flying time, a great portion of it testing and evaluating Air Force planes. He has flown all current production models and research and development aircraft.

Clerk (asking for a raise): I cannot even buy a pair of shoes.

Boss: Then I'll have to let you go. We can't tolerate bare feet around here.

* * *

Judge: One year and fifty dollars fine.

Lawyer: I move to have the sentence reversed.

Judge: Granted. Fifty years and one dollar fine.

* * *

A big shot is a little shot that kept right on shooting.

Two ghosts sat upon an overturned tombstone to talk shop.

"By the way, pal," asked one, "do you believe in human beings."

* * *

Yesterday is a cancelled check; tomorrow is a promissory note; today is the only cash you have. Spend it wisely.

It was a hearing to investigate a case of suicide. When the jury filed back in, the foreman arose and gave the verdict: "The jury is all of the same mind—temporarily insane."

* * *

Visitor: What will you do when you are as big as your Mother?

Little Susy: Diet.

* * *

"Can the baby talk yet, Tom?"

"You betcha. Now we're teaching him to keep quiet."

* * *

Some people think they are big shots just because they explode.

—*Arkansas Baptist*

* * *

The art of acceptance is the art of making someone who has done you a small favor wish that he might have done you a greater one.

* * *

If you keep an open mind, there's a chance that something valuable might drop into it.

* * *

Do the best you can. The forests would be very quiet if all the birds were quiet except the best singers.

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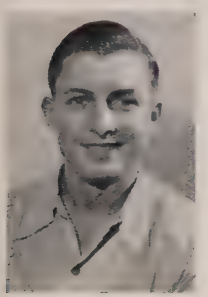
DUCTILE CAST IRON

by Larry Kiefling, M. E. '56

All ferrous metals are composed of one or a combination of several crystal and carbon-alloy forms. Each of these forms has greatly different physical characteristics.

Pig iron as it comes from the blast furnace may contain as much as 4.5% dissolved carbon. The cementite which is formed is very hard and brittle. Much of the carbon must be removed during the manufacture of steel.

The carbon content of gray iron is greatly reduced by the addition of a large amount of steel scrap to the charge. The metal is cooled slowly and



LARRY KIEFLING is a sophomore in Mechanical Engineering. His home town is Cowden, Illinois. Besides being a regular contributor and hard-working member of the Tech staff, Larry boasts a 4.5 average.

the carbon is caused to precipitate as small flakes of graphite. Since the tensile strength of graphite is very low, the metal also has a low tensile strength. The compression strength is almost unaffected. If the metal is rapidly cooled, white cast iron is formed. White cast iron is composed mostly of hard, brittle cementite. Malleable cast iron is produced by annealing white cast iron. It is both slightly malleable and ductile. The change in properties is caused by the very tiny flakes of graphite which are formed.

At an American Foundrymen's Society meeting in May, 1948, the International Nickel Co. announced a new form of cast iron that may revolutionize the ferrous metals industry. This material, called spheroidal cast irron, nodular cast iron, or ductile cast iron, is manufactured by the same process as gray iron, but has a tensile strength almost as great as more expensive steel.

Dutcile cast iron is made by adding a small amount of an alloying element to cause the graphite which is precipitated in the solution to form into tiny spheres. This spheroidal form minimizes the effect of the graphite until it is neglible. Many of the alkali earth metals have been tried as alloying agents, but Magnesium seems to be the best.

Early efforts to produce ductile cast iron by superheating and the addition of a large amount of silicon met with mixed results. E. Piwowarski reports 100% spheroidization with iron superheated in an acid lining and inoculated with .1% ferrisilicon. Superheating alone, in a basic lining did not produce a spheroidal structure, but spheroidization was produced by the addition of .1% ferrisilicon. It was found that traces of impurities such as titanium carbide or aluminum hindered spheroidal crystalization.

German patent 541,296 (Feb. 1928) covers a process for the improvement of cast iron. It specifies that "free and uncombined metallic calcium must be present in the melt, because only this free metallic calcium effects or promotes the graphite formation." Calcium has produced various degrees of spheroidal graphite in laboratory experiments, but the process has never become commercially important. Some success has been attained with the use of cerium as an alloying metal.

The INCO process has been much more successful than any of the others, however. Over 100 companies had been licensed by Sept. 1950. This process uses a 75% Ni-25% Mg alloy to bring about the spheroidization of the graphite. Alloys such as 80% Cu-20% Mg and 25% Ni-50% Mg-25% Si are used to save expensive nickel. Mg-Si alloys have not given uniform results due to the rapid reaction.

Nickel tends to increase ductility and decrease tensile strength. As nickel is by far the most expensive of the alloying elements, efforts are being made to replace it but little success has been encountered.

While less than .75% copper increases strength and hardness more copper will not dissolve and the strength is lowered. Copper causes a marked drop in ductility. Copper is undesirable where high ductility is needed, but is desirable where increased hardness is needed. The effect of copper is minimized by annealing.

A high silicon content is necessary to obtain a complete modification of graphite form. Silicon has a moderate effect when it forms 1.5% go 2.7% of the solution, but brittleness is caused by more than 3.0% silicon. Tensile strength increases 7,000 psi with each per cent increase in silicon content. This gives a distinct advantage over gray iron where a large silicon content causes large graphite flakes. Ferrisilicon is used in the manufacture of both malleable and ductile cast iron to bying about the change change in graphite structure. The usual practice is to inoculate with ferrisilicon immediately preceding pouring.

Ductile cast iron must be relatively free of sulfer. Since much of the manganese used in cast iron is needed to neutralize sulfer, the manganese content in ductile iron can be substantially lower than in other forms. In gray iron with a sulfer content of .1% and a manganese content of .6%, .45% manganese is needed to neutralize sulfer. Manganese is a strategic material which must be imported. Ductile iron may reduce the need for manganese about 7,000,000 pounds per year.

Carbide forming elements such as chromium should be absent to get ductility in the as cast condition. Phosphorus forms its usual brittle phosphide network within the metal. Ductility varies inversely as phosphorous content up to .2%. Phosphorous does not hinder the formation spheroidal graphite. Annealing does not change the effect of phosphorus.

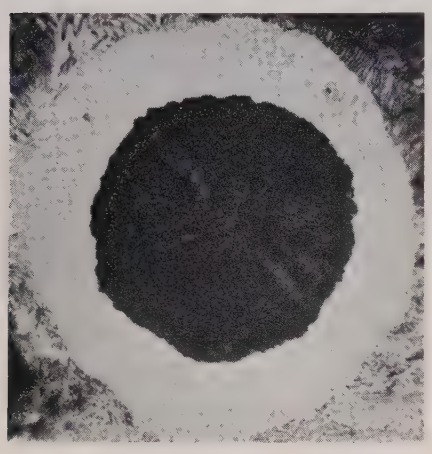
Ductile cast iron has the same process advantages that have made cast iron popular for centuries. The great tensile strength makes economical production of many parts possible for the first time. Production of ductile cast iron is only slightly different than the production of gray iron. The same furnaces and pouring equipment is used although larger gates are sometimes needed. Synthetic green sand is used for molds. Heavier risers are needed on molds because of high coeficient of expansion. The metal has a low melting point, exceptional fluidity, and a high surface tension. These good pouring and molding properties are distinct advantages.

High magnesium loss is a problem that must yet be solved. About 70% of the magnesium added is thrown from the melt as vapor. Ways are being in-

vented to help control this violent reaction. The magnesium yield must be fairly constant in order to get uniform composition with each melt. The composition values need not be so exact if heat treatment is intended.

Production of ductile cast iron in 1949 was 3600 tons. Expected production for 1950 was 15-20,000 tons. Pieces cast ranged from small C clamps weighihng a few ounces to uge hammer anvils weighing 40,000 pounds. Section thicknesses varied from ¼ inch to 36 inches.

Emil J. Loufer of Acme Shear Co., reports that his company is having much



Graphite spheroid in ductile cast iron. (1000x)

success with small castings, even though these must be annealed to get spheroidal graphite. C clamps made by this process could be twisted 90° without breaking. Holes could be punched with no danger of breaking. Annealing ductile cast iron takes only 24 hours while it takes 90 hours to anneal malleable cast iron. No burn-in has been discovered; the sand peels so clean that it is possible to cast sharp edges.

President C. L. Carter of the Albion Malleable Iron Co., is one of the few persons to disagree on the values of ductile cast iron. However, his only trouble is that he has found the cost of annealing high enough to make the manufacture of small pieces uneconomical.

The Chambersburg Foundry Co., has cast some hammer anvils and dies which have been successfully used in industry. Sales for this type of castings is increasing. Cooper-Bessemer Corp., reports successful manufacture of compressor housings which must withstand a pressure of 2,400 psi and of 9 inch deisel engine pistons. Lynchburg Foundry Co., has cast ductile iron pipe which shows many improvements over ordinary cast iron pipe. United Engineering and Foundry Co. reports that ductile iron furnace doors have lasted 17 weeks compared to a 4 week life of gray iron doors. Other foundries report similar success with miscellaneous uses of ductile iron in places where extreme heat and wear resistance was needed.

Fred Freder, foundry superintendent of Valley Iron Works Co., gives the characteristics of ductile cast iron as, "Very close grain structure, develops high finish, welds easily and successfully, high tensile strength, excellent wearability, is free from casting growth problems and its physical qualities can be varied according to the demands of the casting."

The properties of ductile cast iron vary greatly with the type of granular structure. While most work has been done with the ferrite and pearlitic forms, the martensitic and austenitic varieties show promise of many uses. A structure of ferrite is desired to get maximum ductility. To get maximum strength, a pearlite structure is wanted. A martensite form gives the greatest hardness. Ductile cast iron in the as cast state is usually a mixture of pearlite and ferrite. Annealing gives a pure ferrite structure.

Maximum ductility can be obtained by heating to 1600°F, cooling to 1275°F, and holding for 5 hours. A specimen containing .4% manganese and .1% phophorus will have an elongation of 18-23% while a speciman containing .8% manganese and 2% phosphorus will show an elongation of 15% after this heat treatment. Compression strength varies directly with hardness. A test bar with a hardness of 219 Bhn shows a compression strength of 57,000 psi while a bar with a hardness of 321 Bhn will withstand 95,000 psi.

The machinability of ductile iron is very good. The chip produced by ductile iron on the lathe is much longer than that of gray iron, due to the form of the graphite. Annealed ductile iron produces a continuous strip like that of steel. Ductile iron consumes more power

PROPERTIES OF CAST IRON

	Tensile strength	Yield strength	Elongation	Hardness
Gray iron	23,000 psi	———	———	176 Bhn
Malleable iron	44,500 psi	29,500 psi	13.8%	116 Bhn
Ductile iron	99,000 psi	67,000 psi	5.0%	246 Bhn
DI (annealed)	72,000 psi	52,000 psi	17.5%	170 Bhn

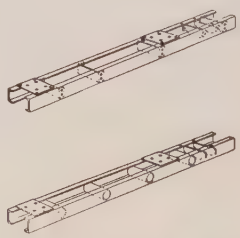
For a successful engineering career, thorough background in welded steel construction is vital since:

GOOD ENGINEERING DESIGNS DEPEND ON COST

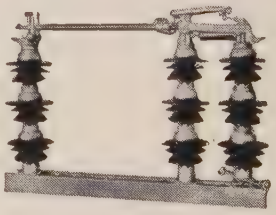
With more and more emphasis being placed on cost of manufacture to meet competition, industry's management today looks to its engineers to initiate money-saving ideas in product designs. As a result, the alert engineering student who can come up with unique money-saving suggestions in his designs will find greater acceptance for his suggestions and a promising future in personal advancement and income.

Often too little attention is devoted to how a product design can be simplified to eliminate costly manufacturing manhours once a basic design is established. To achieve this end, where designers reappraise product details for welded steel construction, production costs are being cut an average of 50% compared with manufacture using castings.

The reasons for the lower cost with welded design are basic . . . lower cost of steel per pound, fewer pounds of steel needed and simpler shop procedures. In addition, steel designs are stronger . . . resist fracture from shock . . . are more modern in appearance.



FORMER BOLTED DESIGN *of base for electric switch. Bases range from 6 to 10 feet long. Are subject to severe cantilever stresses from opening and closing of switch.*



PRESENT WELDED STEEL DESIGN *incorporates tubular cross members. Weight cut 20%. Deflects one fourth as much under load. Costs no more to build.*

DESIGN DATA *for welded steel construction is available to engineering students in the form of Bulletins and Handbooks. Write . . .*

THE LINCOLN ELECTRIC COMPANY
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THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

during machining than gray iron. Ductile iron produces a superior machined surface.

Ductile cast iron can be heat treated to produce superior abrasion resistance. It is possible to produce an object with a hard surface and a ductile, strong interior. The only material comparable to this is steel, cladded with another, more expensive, metal. The possibilities are obvious since ductile iron is much cheaper. Superior plowshears are now being made by this method.

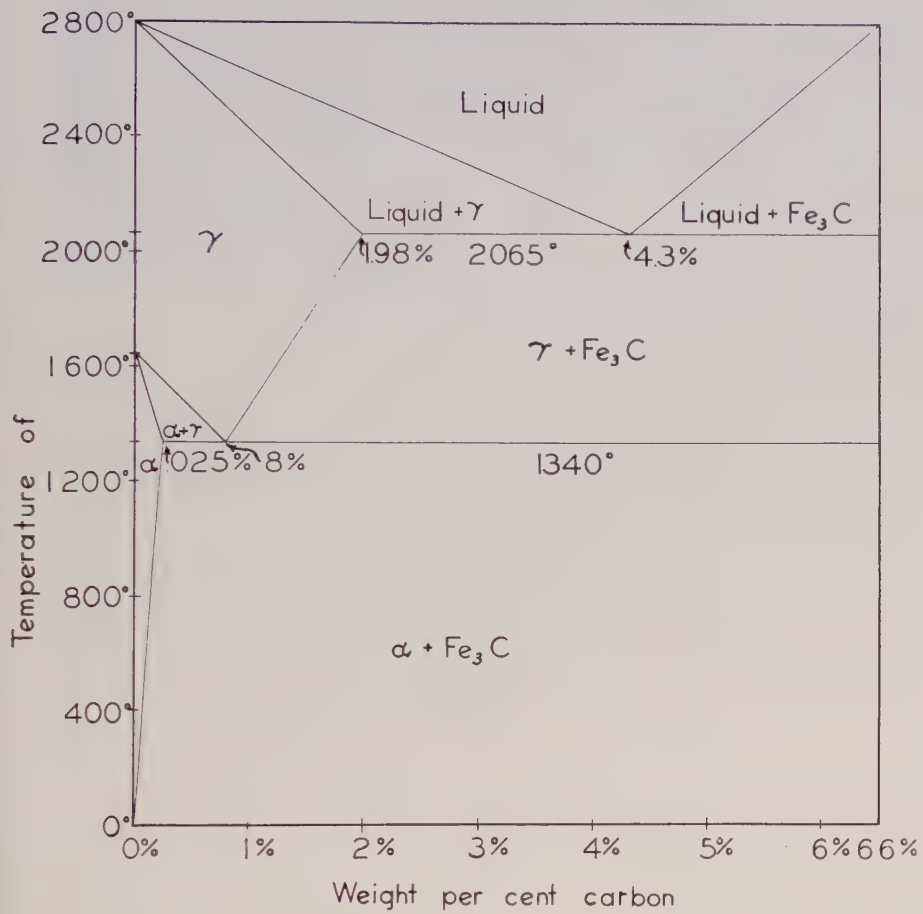
Ductile cast iron is very resistant to extreme heat. On such parts as furnace doors and grates, it far surpasses gray iron. The flake graphite in gray iron causes the trouble by uneven expansion and contraction. Rapid corrosion is the result. In laboratory tests for growth resistance, ductile cast iron was second only to Fe-Ni-Cr alloys.

Tests by INCO show that ductile cast iron wears as well as gray iron, long regarded as one of the best wearing materials. Gray iron is one of the best wearing material in the unlubricated state, because of selflubrication by graphite, but ductile iron equals it.

Lubricated ductile iron bearings last 4 times as long as bronze bearings but cost only 1/3 as much. Ductile iron has good stiffness, torional strength and fatigue resistance.

One of the greatest improvements of ductile cast iron over any other form of cast iron is in weldability. When any ordinary cast iron is heated during welding, white cast iron is formed upon cooling. Ductile cast iron, however can ben easily welded. The spheroidal form of the graphite is not changed in any way. A weld in pipe is stronger than the pipe itself.

Ductile cast iron is replacing cast steel for many uses because of its low cost. Pistons, crankshafts, camshafts, and gears are now being made from ductile cast iron. Ductile iron is used here because of its wear resistance, hear resistance, and its high tensile strength. Ductile cast iron is being used in pumps, compressors, and pipes. Gray iron could never be used for pressure equipment because of the small leaks which develop through the graphite flakes. Cast steel cannot be cast into the complex designs of compressors. Designs which have been on file for years because of production difficulties are being cast in ductile iron. Eight inch ductile iron pipe withstood a pressure of 5,300 psi before it ruptured, but gray iron pipe shattered at 2,400 psi. Ductile cast iron is being widely used in agricultural, mining, and milling machinery.



The alpha form is called ferrite, the gamma form austenite. The compound Fe_3C is called cementite. A eutectic (called lederburite) exists at 4.3% carbon and a eutectic (pearlite) at 0.8% carbon. The region to the left of 1.98% carbon is steel, except the pure alpha ferrite. The region to the right of 1.98% carbon is the cast iron region.

The young bride was asked what she thought of married life.

"Oh, there's not much difference," she replied, "I used to wait up half the night for George to go, and now I wait up half the night for him to come home."

* * *

We are told there is a fundamental difference between what is illegal and what is improper. I do not see this difference, because what is illegal is merely one of the improper things that happens to have been the subject of legislative action.

* * *

About the time you're important enough to take two hours for lunch, the doctor limits you to a glass of milk!

* * *

The lady of the house was showing the new maid about the premises. As they walked into the dining room, she said, "This dining room table goes back to Louis the Fourteenth."

"That's nothin'" interrupted the maid, "my whole living room set goes back to Sears the 15th."

* * *

One thing we like about babies is that they don't go around telling bright things their mothers and fathers have said.

—*Great Bend Tribune*

* * *

There are not many people you can outsmart, but you can outwork quite a few.

* * *

One thing you can never give away is kindness. It always comes back.

* * *

You don't have to stay awake nights to become a success. Just stay awake days.

* * *

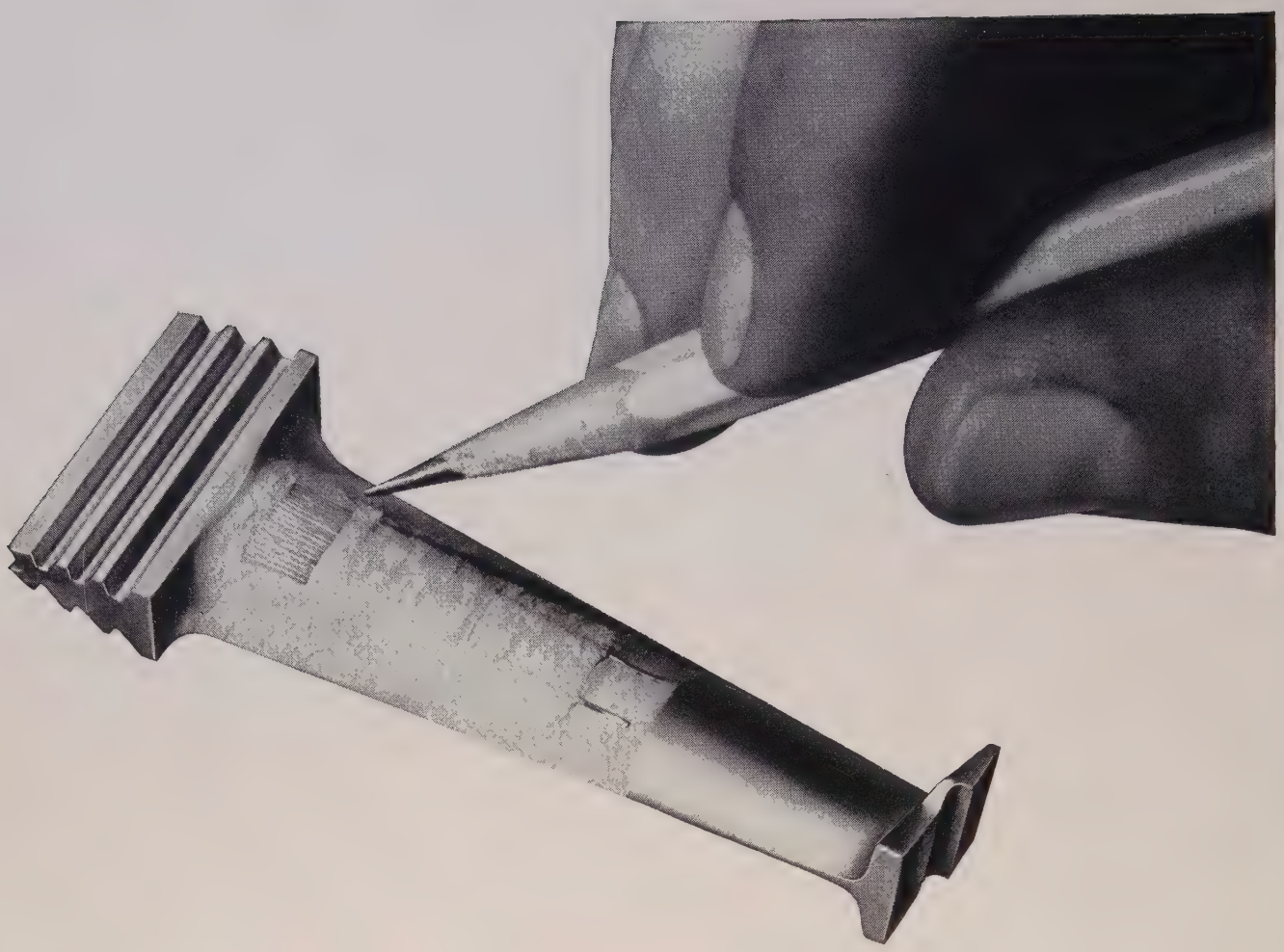
A man should never be ashamed to admit he has been in the wrong, which is but saying in other words that he is wiser today than he was yesterday.

* * *

There is a loftier ambition than merely to stand high in the world. It is to stoop down and lift mankind a little higher.

* * *

If cows knew how much milk was selling for, they wouldn't just be contented—they'd be hilarious.



important wire on a hot subject . . .

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This basic information, in turn, permits the design of blades that combine the optimum aerodynamic characteristics with structural integrity.

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Nothing can be left to chance in the design of aircraft engines for supersonic flight. Thus we use — and frequently improve on — every advanced technique and engineering tool. This straight-forward approach to engineering problems is one of the reasons many outstanding engineering graduates decide on a career at Pratt & Whitney Aircraft.

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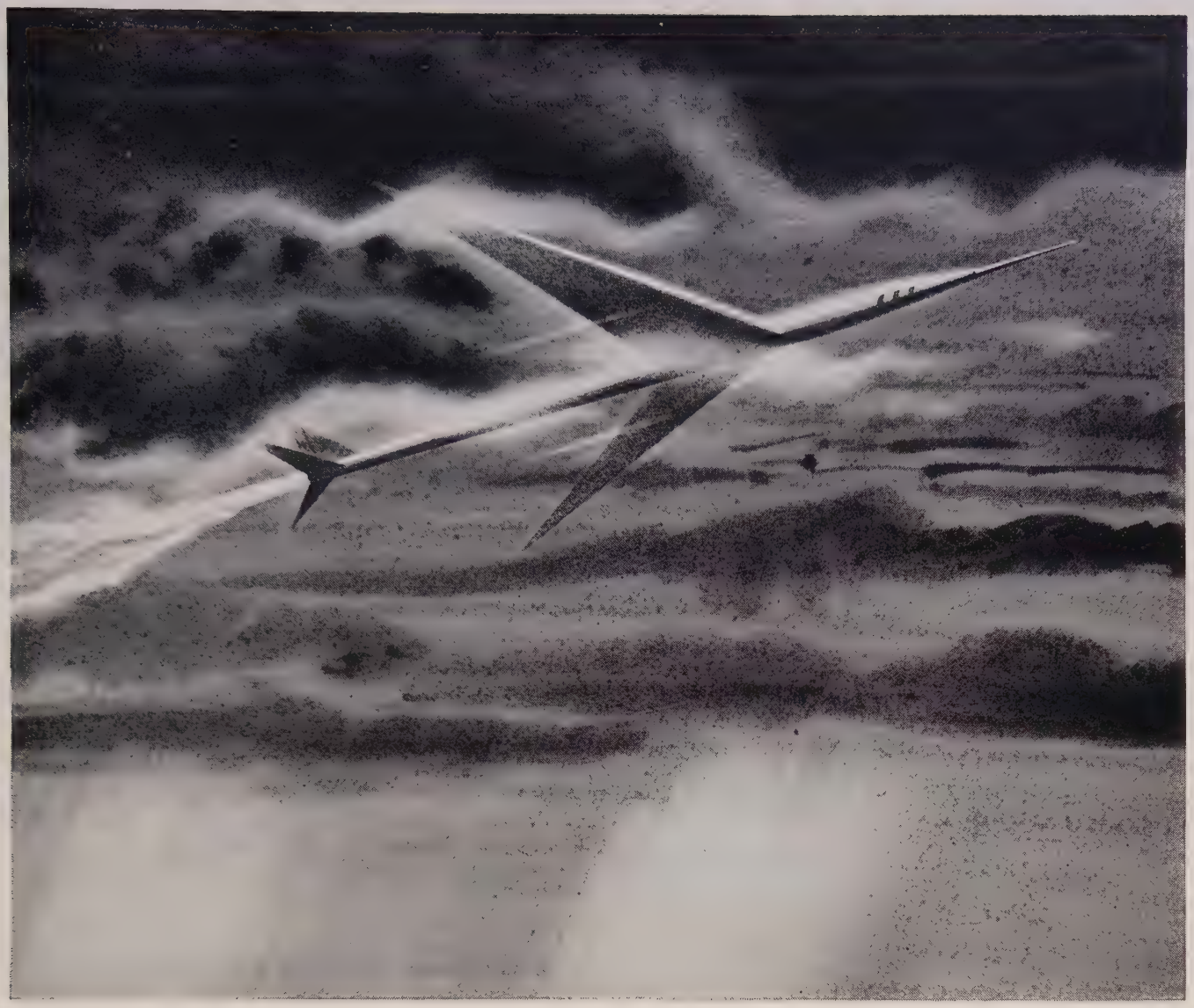

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You'll find Boeing a stable 37-year-old company, that has grown practically continuously. For example, Boeing now employs 6000 engineers in contrast to 3500 at the peak of World War II. And although Boeing is a large concern, it is so organized that each engineer is an individual who stands out—and progresses—in proportion to his ability.

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JOHN C. SANDERS, Staff Engineer — Personnel
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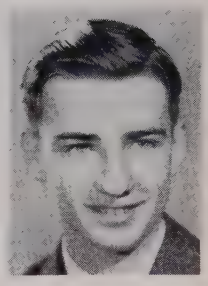


DON KESLER is a sophomore in Electrical Engineering. Besides his school work and the Technograph, he works on meters in the Instruments Lab. in the E. E. Building. Don is a permanent resident of Urbana.

by Don Kesler, E.E. '56

According to the advertisers, Detroit is producing some fine sports cars. This misuse presents a question, what is a sports car? A sport car is a low, small, light-weight car capable of negotiating sharp corners at high speeds. It must have head lights, tail lights, and full road equipment for operating on the highway. It also must have a horn, spare tire, and fenders.If the fenders are the cycle type, they must extend at least an arc of 120 degrees along the wheel and be at least as wide as the tire. Most sports car enthusiasts shun at cars with cycle fenders as being strict racers with covered wheels.

Sports cars must be built to be driven on service station gasoline, since this is what is allowed in sponsored sports car races. The only gasoline that may be used is furnished by the officials, so that rules out all alcohol and nitro mitures. It also keeps sports car racing from getting out of reach of lots of would be enthusiasts. Any carburetor or manifold modifications are legal except in strictly stock classes.

Does your Detroit buggy classify as a sports car? It has headlights, tail lights, a horn, and a spare tire. It has fenders; it will run on regular gas. Oh, yes, it won't turn sharp corners at high speeds.

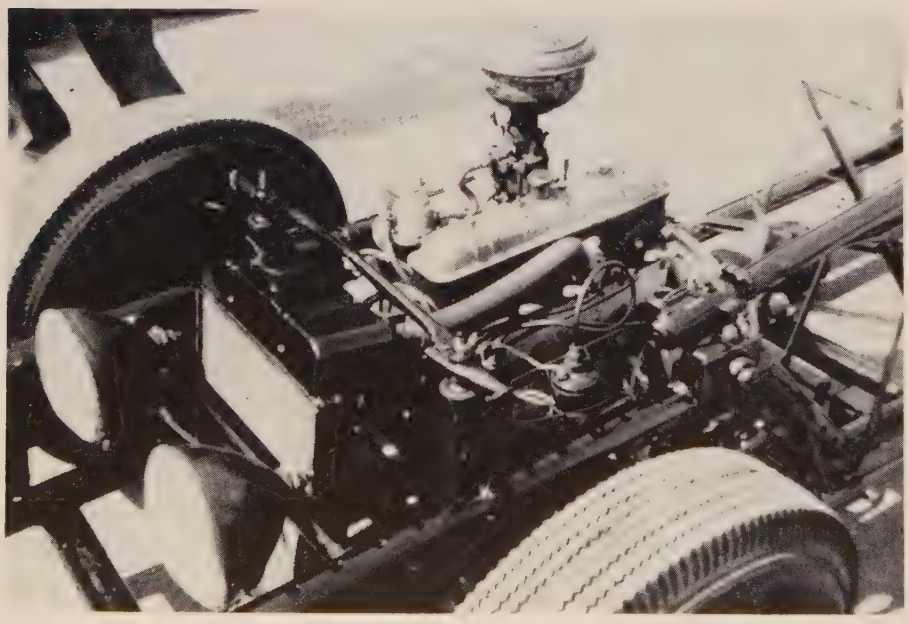
Turning sharp corners at high speeds is the whole idea of sports cars. The car must have light, quick steering that allows for fast corrections. The suspension must be smooth and firm to give good lateral stability on the turns. Detroit's soft suspension causes body roll in high speed turns, thus the car won't stay under control. Do not put all the blame on the Detroit engineers, though, because it is not their fault that women control America's money.

A good sports car must have a low center of gravity and good brakes. By a low center of gravity I mean a few inches above the axle. The lowest center of gravity of any American car is a little less than two feet above the ground. Good brakes will last all day without showing signs of fading. This year's Le Mans twenty four hour road race was won by a Jaguar because it had better brakes than the American built Cunningham. The Jaguar could go farther into a curve before it had to apply its brakes. There was nothing wrong with Cunningham's brakes, only Jaguar's were better. To attain a low center of gravity and finally, high speeds, the car must have a low body line. Wind resistance may not be much in town driving, but it means a lot at 160 miles per hour.

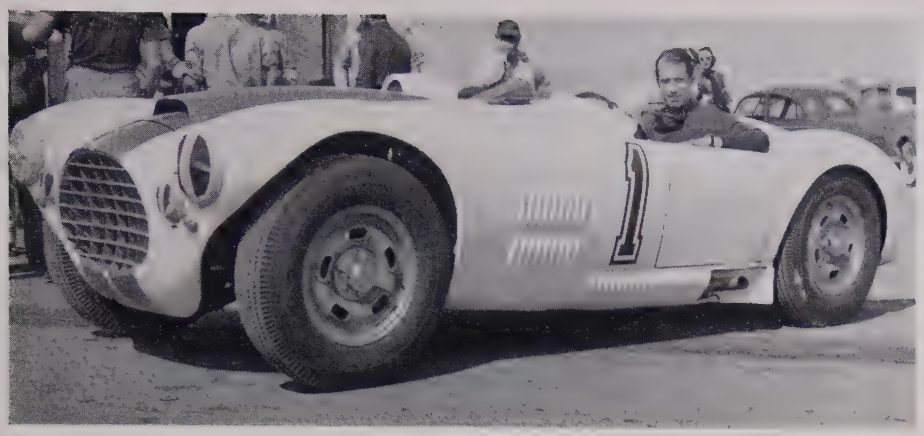
As you can readily see, these cars are safer than most American cars, because they have better brakes and will not roll over. If a sports car is going too fast to turn a corner, it won't roll over; it will skid on all four wheels, if properly driven. Even then the sports car will be going much faster than the American car.

A sports car is balanced. It has 50 percent of its weight on the front and 50 percent on the rear wheels. This gives it better traction than American cars with generally 60 percent of their weight on the front and 40 percent on the rear. Poor balance is what caused power steering to be created. The extra weight on the front wheels caused the car to steer hard. The engineers use either high steering ratios or a power linkage to combat the hard steering. No racing cars have power steering because it takes away the feel of the road.

It's fun to drive a sports car. It's



Notice the tubular frame of the Crosley. Norman Goelzer, M.E. '56, built this sports car last summer.



The C4R Cunnningham and Johnny Fitch have won a lot of races together. This race was at Tampa, Florida. (Photo by Dick Adams, Speed Age)

balanced; it has quick steering; it has plenty of traction. The best of brakes and firm suspension make it a safe car. Where can you find such fine qualities in Detroit cars? Sports cars may not have as much horsepower as American cars, but they don't carry all that excess weight around either.

Being a sports car does not limit a car to any body style. It may be a roadster, hard top, convertible, or a family sedan. Most sports cars are factory built, but a lot of fine ones are built at home.

A highly successful example of the home built sports car is the plastic bodied Crosley. The chassis consists of Crosley suspension attached to a tubular frame. A modified Crosley engine is mounted on the chassis to fit the original drive shaft. The 12 inch Crosley wheels are replaced by 5:00 X 15 inch wheels. Layers of fiber glass cloth are placed in a mold and saturated with polyester resin to form the body. The Fiber Sport Crosley is a nice looking, agile car weighing about a thousand pounds. It is capable of over a hundred miles an hour. The total displacement of this engine is a little larger than an cylinder of a Chrysler or Cadillac V-8. A Hundred miles an hour with that engine is quite an achievement.

July, 1952, was a black month for 60,000 Crosley owners. Crosley had gone out of business. The cause of its failure was the reputation of the copper-brazed Cobra engine. The engine warped, rusted out of shape, and leaked a mixture of oil and water. Over 45,000 cars were originally equipped with this engine, although some of these were replaced with the cast iron block Ciba engine which was standard after 1949. The overhead cam Ciba proved to be a successful racing engine in Crosley's attempt at sports cars—the Hotshot and the Super Sport. What would happen to the poor Crosley owners? Shortly after Crosley's failure, the Crosley Car Owners Club was organized. They set up a parts service and service booklet covering all repairs from the bumpers to the engine. Their organization of 600 members has already saved lots of Crosleys from the junk yard.

Jaguar has come a long way in the mass production of sports cars since 1949. The famous XK 120 Jaguar was born that year. A strictly stock XK 120 roadster, using ordinary gasoline, attained a speed of 132.6 miles per hour in Belgium for the record speed of mass produced automobiles. Later, a hardtop coupe ran continuously for seven days and seven nights at an average speed of over 100 miles per hour.

The competition Jaguar won its first race at Le Mans in June, 1952. The "C Jag" has a 210 horse power version of the dual overhead cam XK 120 engine with a tubular chassis and aluminum body. With a weight of 2200 pounds, the car has almost a horse power for every 10 pounds. In 1952 the Jaguar got too panicked by the Mercedes team and the car overheated early in the race. Le Mans in 1953 went to Jaguar with the aid of a juiced up engine and spot brakes. The new C Jag has about 160 miles an hour top speed. Some of the other cars had a higher top speed than the Jag, but the Jag could go 200 yards farther into a curve before they had to apply the brakes, than their competition.

Mark VII Jaguar is the fastest mass production sedan in the world. The four door aristocratic sedan has been clocked at over 121 miles an hour. The sedan possesses the qualities of a sports car.

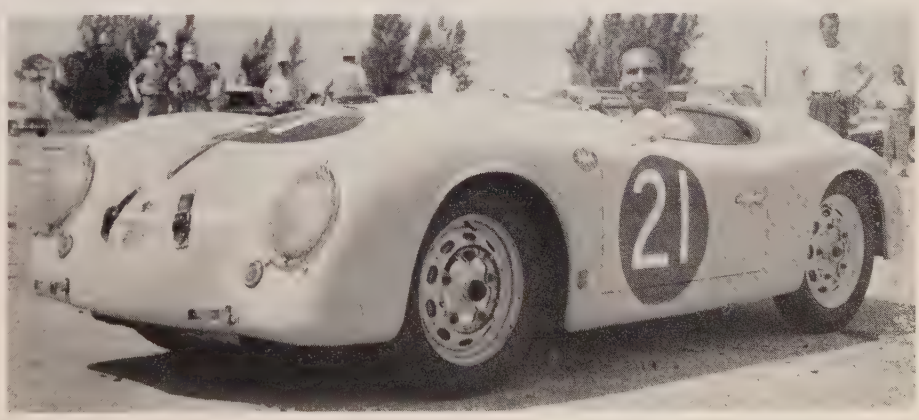
Where else can you get such a racing machine as the XK 120 roadster, hardtop coupe, or Mark VII sedan for $4200? The competition model sells for a modest $5,800 in the U. S.

America's only sports car in the present era, grew out a hope of Briggs Cunningham. If the hope of any America can come true, it wouldn't miss Mr. Cunningham by far, since he inherited a major part of Proctor and Gamble and a healthy portion of Standard Oil.

Cadillac heartily assured him that without any hopping up, the 1950 Cadillac would easily win the Le Mans race that year. Lacking the confidence of GM, he bought two of them, souped them up, and accomplished a magnificent feat—tenth and eleventh place among the best European sports cars.

In the following year, 1951, Cunningham converted the Chrysler V-8 to put out 310 HP, mounted it on a tubular chassis and had a body built on the chassis. The cars were complete without any testing just a week before sailing time. Two of his cars spun out and wrecked in the heavy rain early in the race. After running in second place for twenty hours, the third Cunningham overheated due to a misunderstanking on the kind of gasoline that would be used in the race. Despite bad bearings the car managed to cross the finish line in 18th place.

In 1952, value trouble stopped two of his cars, but Briggs drove the third to take fourth place. With equally poor luck in 1953, the three American starters finished third, seventh and tenth. His present car, combined with better brakes, should prove a greater threat in the 1954 contest.



The competition Porsche roadster is a soft riding, fast car. Harry Grey drove it at Sebring, Florida. (Photo by Dick Adams)

At his West Palm Beach factory, in

Another example of opportunities for engineers at LINK-BELT

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13,030-A

Florida, Cunningham builds the frames, and mounts the modified Chrysler engines. He ships the chassis to Italy to have a Vignale body fitted on it. You can buy one of America's only sports cars for $10,000 if you have it.

The most popular sports car in America today, is the British imported MG. Plenty of Americans have bought MG's because their Detroit car was beaten by a little car that they could almost put in their trunk. Priced at $2,100 there are over 30,000 MG's in the U. S. today. Until recently, the MG was king of the 1500 cc displacement class. It is still the best buy for a new comer to sports cars. A lot of famous drivers got their start by driving MG's. John Fitch was driving MG's until 1951, when Tom McCahill suggested that he co-drive one of Briggs Cunningham's cars at Le Mans. Since then, he has won more major sports car races than any other driver.

The MG is a sports car in the best tradition. It corners with the greatest of ease and has a four speed gearbox. The engine is small and not powerful, but with this transmission it goes. The little MG, with a top speed of 80 to 85 miles an hour, will beat any American car except the Cunningham on any crooked road. The American car will beat the socks off the MG on the level road, but the MG can make up the time on the corners.

Porsche was the first class F car, 1100 to 1500 cubic centimeters, to soundly beat the MG's. The German Porsche, is a radial design, with a four cylinder opposed engine mounted in the

Jim Kimberly, holding the helmet, is the proud owner of this 2.6 Ferrari. (Photo by Dick Adams)

rear. It has four wheel independent suspension with about nine inches of wheel travel. The employment of the trailing link suspension makes possible the soft ride with horizontal stability. Torsion bars parallel to the axle produce the spring action. The wheels follow the torsion bars like swivel casters without the swivel. The action of the wheel is vertical with a little action forward

John Rutherford drove his XK 120C Jaguar to a record at Daytona Beach. (Photo by Dick Adams)

and backward, due to the arc about the radius of the offset between the torsion bar and the axle. This takes out most of the roll tendencies of the conventional "A" arms that are used on most American cars. It is impossible to imagine such a soft ride, yet such excellent cornering qualities. There is no steering movement over rough roads at the top speed of 110 miles per hour. This aerodynamically styled car sells for $3400 in New York. The roadster and coupe bodies are made of hand hammered steel. The body of the competition model is hand made of aluminum for light weight.

O.S.C.A. is the latest 1500 cc champion. Although OSCA is written and pronounced as a word, the letters are the initials of the Officine Specializzate Costruzione Automobile of Bologna, Italy. The OSCA is built by the famous Maserati brothers. Recently they left the Maserati company, but their high caliber of automobiles is equally evident in the OSCA.

The engine of the OSCA is a four cylinder duel overhead cam. It comes in three sizes—1100 cc, 1342 cc, and 1480 cc. The little OSCA has the 1100 cc engine that puts out 80 horsepower. The next size has the same streamlined body with the enlarged 1342 cc engine and 98 HP. The big OSCA has the 1480 cc engine in a larger body. The price ranges from $7000 for the small OSCA to over $9000. The demand is so great that you have to be content with your name on the waiting list. Although there are less than a dozen in the United States, they have established an amazing record for themselves. The fastest OSCA has a top speed of over 125 miles an hour.

The hottest thing on four wheels, the last few years, is the V-12 Ferrari. The Italian Ferrari is the most consistent winner, and has been unchallenged until the C Jags came along. The reliability of this racing machine is excellent, but the extra equipment, upkeep, and repairs have a habit of being proportional to the initial cost. There are five different V-12 Ferrari engines—1.9 liter, 2.6 liter, 2.9, 4.1 America, and 4.1 Mexico. The bore of the 2.6 engine is only 2.7 inches, and the stroke is 2.23 inches. The *strokes* of all the engines are the same, thus the bore and other modifications are the only changes. The 1.9 liter engine developes 160 horsepower and the car sells for $9,500. The 2.6 has 170 HP; the 2.9 puts out 240 HP. The difference between the 4.1 America and the 4.1 Mexico is 50 horsepower. The 4.1 Mexico is the more powerful with 270 HP and sells for $16,600.

Enzo Ferrari is not the least bit interested in mass production or economy. He wants to build the fastest and best car. These beautiful, complex machines are fast, 170 miles an hour, and at $9,500 and up, they are certainly economical.

Not all European cars are sports cars. In fact, most of them are built for low initial cost and gasoline economy, thus they are not sports cars. They are no nearer sports cars than most American cars.

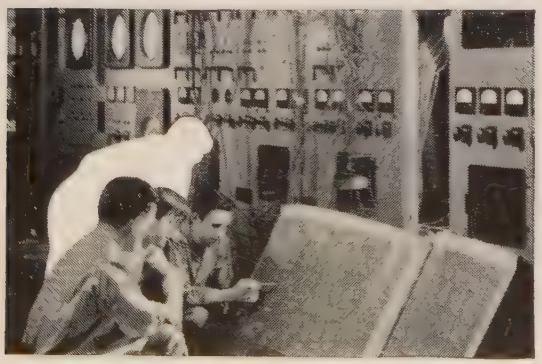
Detroit's experimental sports cars are not real sports cars. Using the Cadillac El Dorado for an example, a car with a 126 inch wheelbase, 58 inches high, and 220 inches long cannot be called a sports car. This car is just another of Detroit's monsters. The car weighs enough to make two good sports cars. Good maneuverability comes from a short wheelbase. Most sports cars have a wheelbase of less than 100 inches. A sports car enthusiast will not call a car with a height of 58 inches low. A sports car with automatic transmission and power steering is absurd. Chevrolet Corvette, Packard Caribbean, Buick Skylark—all of them are basically the same car with a different look.

The public wants a real American sports car. Cunningham is producing sports cars, but John Q. wants something to fit his wallet. A $3000 American sports car would break selling records. What is your answer, Detroit?

Sales Engineering

Market Development

Product Engrg. & Research



Industrial Engineering

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More and more industries are depending upon instruments to control production lines . . . to solve research problems . . . to test products. Iron and steel, aircraft and autos, chemicals and chinaware, petroleum and electrical power are only a few of the many basic markets for controlling and measuring equipment. As a result, expenditures for instrumentation have been increasing yearly until today they amount to several hundred millions of dollars—a figure which will continue to increase.

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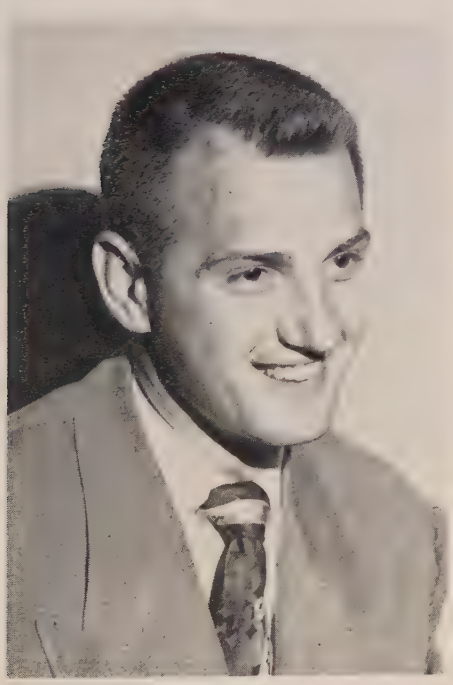
by Charles Runyan, E.E. '57 and
Donna Rudig, E.E. Physics '57

MIKE ZIHAL

The *Illinois Technograph* proudly continues to introduce personalities of the engineering campus. This month we are featuring engineer extraordinary, Mike Zihal, president of the Engineering Council. Mike, a graduate of Brooklyn Technical High School, Brooklyn, New York, was elected to office last spring. While in high school he majored in architecture and was a member of the swimming and football teams. Immediately upon graduation Mike spent 18 months with the 37th Infantry Division in the South Pacific. Mike is also a veteran on the council, having been a member for the past year. He is also president of the Sanitary Engineers.



MIKE ZIHAL

Last year Mike was a member of the St. Pat's Ball Committee and also won a scholarship in sanitary engineering, which he is majoring in. Besides being president of the Engineering Council, Mike still finds time to belong to the American Society of Civil Engineers.

Mike spends most of his spare time at woodworking, which is his hobby, and at supporting his favorite baseball team, the "Dodgers." During his 26 years, Mike has led a busy life, but somehow managed to find time enough to spend with his best girl, Dorothy, who is now his wife of two years.

Most of his summer vacations were spent working for the War Department in Champaign, but for Mike the part-time work is just about over, for upon graduation in February, he will start work as an engineering superintendent in Freeport, Illinois.

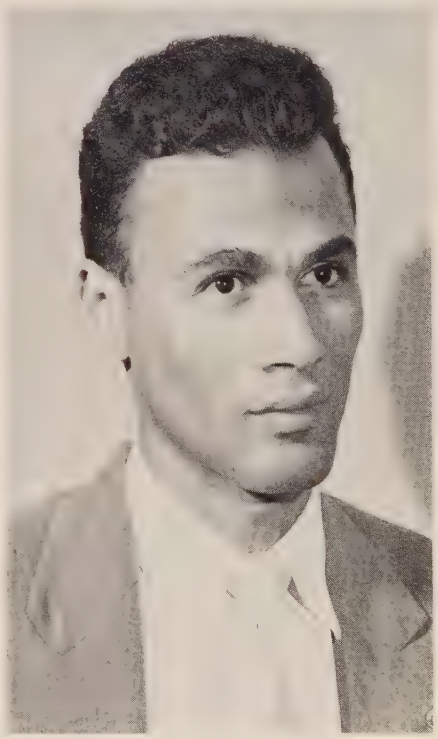
As this soft-spoken, sincere, and outstanding engineer leaves the campus to take his place in society, the members of the *Technograph* give this final salute and a wish for continued success.

PAUL LA VIOLETTE

One of the best known members of the Technograph Staff is Paul LaViolette, our business manager. Now a sophomore in Electrical Engineering, he is following the interest of electricity he acquired while serving in the Navy as firecontrolman. Three of his Navy years were spent overseas, one in Europe and two in Cuba where he picked up his favorite sport, spearfishing, in fact, a Stinger Rey he speared still holds the record for its type in the area.

Paul graduated from Charleston High, Charleston, South Carolina, in 1948 where he was a member of the track and swimming teams. Since entering the University in September 1952, Paul has been carrying extra courses so that he can graduate in August '55. He then hopes to join the Howard Hughes Research Company in Culver City, California.

In July, 1953, when getting his discharge in Virginia, Paul married a rebel beauty. The LaViolettes are expecting a boy (they hope) in February.



PAUL LA VIOLETTE

NO. 4 IN A SERIES

The Importance of

Coverings and Sheaths fo

THE TERM "COVERINGS", as applied to insulated electrical wires and cables, refers to a relatively continuous homogenous layer or layers of impervious and inert material, applied over an insulated conductor or conductor assembly for the purpose of protecting such conductors from moisture, chemical attack and mechanical damage. Coverings may be colored to indicate circuit identification. Chemical attack refers to damage to the insulation resulting from acid, alkalies and other chemicals in the atmosphere or the ducts or soil in which the cables may be installed. Mechanical damage may result from the abraiding, compressing, cutting and tearing forces to which the insulation may be subjected during installation and service.

Coverings may be made of metallic or non-metallic materials. Metallic coverings may be, (1) a continuous metal tube over the insulated conductor, usually made of lead and known as a lead sheath, (2) metal tapes applied spirally about the insulated conductor and referred to as an armor or a shield, depending on the purpose for which it is used, or, (3) metal wires applied spirally either in one direction or in the form of a braid, and again known as an armor or a shield. Armor is a covering applied primarily for mechanical protection or to add strength while a shield is applied to protect the insulation from electrical stresses or for safety purposes. Non-metallic coverings may consist of, (1) a continuous layer of vulcanized rubber or rubber-like material, generally neoprene, or a thermoplastic material, called a jacket, (2) spirally applied, moisture-resistant fibrous yarn, usually cotton or jute, (3) moisture-resistant fibrous tapes, or, (4) moisture-resistant fibrous braids. Combinations of one or more of these may be used as explained later.

The kind and number of coverings used is determined largely by the size of the conductor or cable, the type of insulation on the conductor and the installation conditions. The following is a brief outline of the types of coverings required for the more important types of insulations and installation conditions.

INSTALLATION in DRY CONDUITS and DUCTS

Single-conductor rubber and varnished-cambric insulated cables require a covering over the insulation consisting of a moisture-resistant cotton braid on the small sizes and a double braid or tape and braid on the large sizes for protection against mechanical damage. On 600 volt cables for installation in buildings this covering must be flame-resistant, and is usually colored for circuit identification. A thin layer of neoprene may replace such fibrous coverings on rubber-insulated cables. Paper-insulated cables require a lead sheath for retention of the impregnant and for mechanical protection. Single-conductor polyvinyl chloride insulated cables usually require no coverings since they are generally considered resistant to flame and chemical and mechanical damage.

Multiple-conductor cables which consist of two or more single conductors assembled as a unit are protected by an outer covering. The individual conductors of multiple-conductor rubber insulated cables are generally protected by a single fibrous covering. The outer covering of multiple-conductor cables usually consists of a tape and moisture-resistant cotton braid on rubber and varnished-cambric insulated cables. A neoprene jacket may replace the outer braid on rubber-insulated cables. A polyvinyl chloride jacket is generally used on polyvinyl chloride insulated multiple-conductor cables. Multiple-conductor paper-insulated cables have a lead sheath over the assembled insulated conductors.

INSTALLATION in WET CONDUITS and DUCTS

The coverings described for use in dry locations on both single- and multiple-conductor cables are suitable for use in wet locations except that a lead sheath is required over varnished cambric and non-moisture-resistant rubber and polyvinyl chloride insulations.

Moisture-resistant rubber insulation requires mechanical protection in the form of a fibrous covering or coverings or a neoprene jacket. A neoprene jacket is preferred because of its greater resistance to deterioration in wet locations. Moisture-resistant polyvinyl chloride may be

nsulated wires and cables

used without a covering on single-conductor cables.

AERIAL INSTALLATIONS

The types of coverings described for use in wet locations are generally suitable for aerial installations but greater thicknesses of non-metallic coverings, particularly for single-conductor cables, are required. Fibrous coverings for aerial use are usually made of moisture-resistant jute, sisal or loom-woven cotton of large size. Neoprene jackets on single-conductor cables for aerial installations are about 50 per cent greater in thickness than those used for duct installations. These thicker covers provide the additional mechanical protection required for aerial installations. Neoprene jackets are generally preferred over fibrous or rubber jackets because of their greater resistance to weathering. Lead-sheathed cables with the same sheath thickness as used for duct installations are suitable for aerial installations. A lead alloy containing small amounts of antimony or tin is used instead of pure lead to reduce failures due to crystallization.

DIRECT BURIAL

For direct-burial installations, rubber, rubber-like or thermoplastic jackets and lead sheaths are generally used. The jacket or sheath thicknesses are the same as those used for aerial installations. Lead sheaths require protection against mechanical damage. This usually consists of two servings of moisture-resistant jute yarn immediately over the lead followed by two steel tapes over which are applied two servings of moisture-resistant jute.

SUBMARINE and VERTICAL CABLES

Submarine cables require protection against mechanical damage and additional strength over that provided by the conductors to prevent them from being broken by dragging anchors or other objects. Vertical cables frequently require greater strength for their support than that provided by the conductors. This additional strength and mechanical protection is usually provided by a serving of steel wires which completely covers the surface of the cable. This is known as a wire armor. A bedding consisting of two moisture-resistant jute servings is provided between the non-metallic jacket or lead sheath and the armor wires.

PORTABLE INSTALLATIONS

Cables for portable installations such as those used on dredges, shovels and mining equipment must be flexible and their sheaths must be resistant to abrasion, cutting and tearing. Tough wear-and-weather-resistant rubber or rubber-like jackets are therefore used. Such jackets are generally made in two layers with a reinforcing braid of high-strength cotton yarn between them. The jacket thicknesses for such cables are generally greater for a given size of cable than those of cables for non-portable installations.

SHIELDING

Shields consist of one or more conducting layers on insulated electric power cables, the purpose of which is to confine the dielectric field to the insulation on the individual conductors. The two most important functions of shields are, (1) to protect the insulation against harmful electrical stresses and discharges at its surfaces, and, (2) to reduce hazards of shock.

Since harmful electrical stresses can occur at both the internal and external surfaces of an insulation, particularly on stranded conductors, at high voltages, it is necessary to provide shields at both surfaces. Internal shielding in the form of a semi-conducting fibrous material is generally used immediately over the conductor for operating voltages above 2000. External shielding usually consists of a semi-conducting fibrous layer immediately over the insulation over which is applied a layer of metallic material. External shields are generally used at voltages above 3000 for non-metallic jacket cables and above 10,000 for lead-sheathed cables.

Metallic shields are made of non-magnetic materials such as aluminum or copper and are applied as tapes on cables for non-portable installations and as braids for portable cables. External shields must be grounded at all joints and terminals.

For reprints of these pages write to address below.

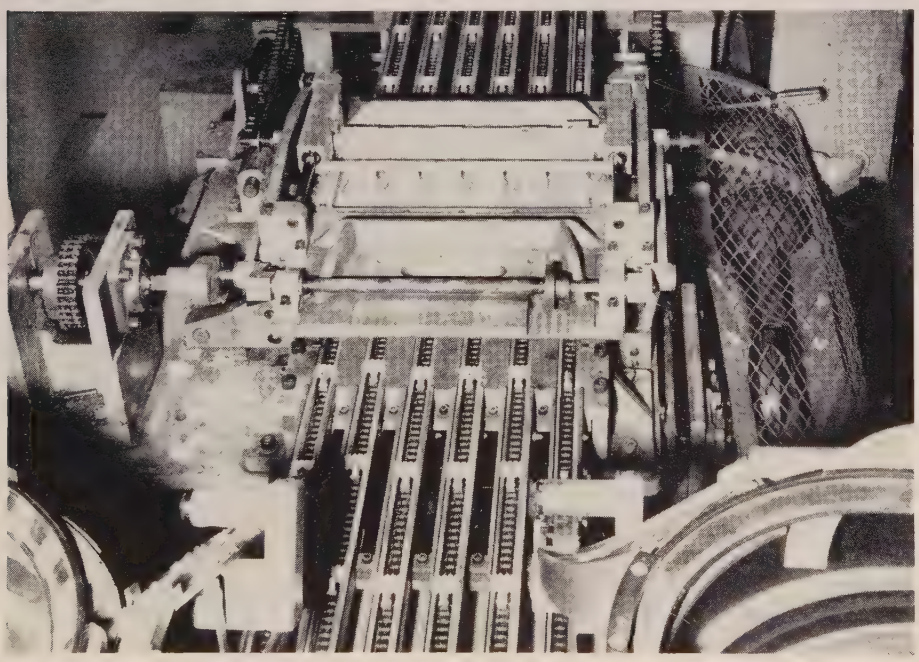
Electrical Wire and Cable Department
Rockefeller Center • New York 20, N.Y.

PROJECT TINKERTOY

(From National Bureau of Standards, U. S. Department of Commerce)

An automatic production line for the manufacture of electronic products and a novel system of electronics design which makes this possible have been developed by the National Bureau of Standards. The program, code-named PROJECT TINKERTOY, was sponsored by the Navy Bureau of Aeronautics.

Starting from raw or semi-processed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits and mount resistors, capacitors, and other miniaturized component parts on standard, uniform steatite wafers. The wafers are stacked very much like building blocks to form a module that performs all of the functions of one or more electronic stages. Automatic inspection machines check physical and electrical characteristics of the parts-mounted wafers at numerous stations along the production line. The completed module is a standardized, interchangeable subassembly combining all of the requirements of an electronic circuit with ruggedness, reliability, and extreme compactness.



MPE wafer pattern printer. As wafers are issued from feeder, they are printed simultaneously with the appropriate silver conducting circuit.

Description of Project

PROJECT TINKERTOY was begun by NBS in May 1850 and now successfully produces electronic subassemblies by mechanized means. The pilot plant is operated by a commercial contractor as part of a large-scale production evaluation program under the Bureau's technical direction. The basic objective of the Navy Bureau of Aeronautics in establishing the program was the development of facilities or systems suitable for rapid mobilization in emergency periods. The facilities are also dual-purposed in nature, and are expected to substantially reduce lead time in production.

The key to the automatic, mechanized production of electronic equipment in PROJECT TINKERTOY is the design system developed by the National Bureau of Standards. Called MDS—for Modular Design of Electronics—the system establishes a series of mechanically standardized and uniform modules (or building blocks), producible with a wide range of electrical characteristics.

Each module, in general, consists of some 4 to 2 thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of individual modules are combined to form a major subassembly. The composition of modules into major subassemblies of electronic equipment is possible because there is great similarity between circuits and parts of circuits in modern electronic tubes and arrays of simple parts (like resistors and capacitors), which account for the mass of the individual parts and are also responsible for the bulk of the manual production efforts in conventional production. There assemblies have been the chief target for redesign in the MDE system.

The production of modules and assemblies, designed in accordance with the MDE system, is achieved mechanically in PROJECT TINKERTOY. The production system developed by the National Bureau of Standards is called MPE—Mechanized Production of Electronics. MPE largely utilizes noncritical raw materials. Ceramic wafers —7/8 inch square by 1/16 inch thick—are produced directly in quantity from the raw ingredients. Ceramic capacitors are produced in a similar fashion. Another part of the line produces adhesive tape resistors.

These and other basic parts are fed into the production line. The appropriate circuits are printed by automatic machines. The circuit configuration is achieved through photographic processing. Quality control is established by

automatic inspection, directed by information prepared in punched card form. Special components, not suitable for "printing" techniques, can be incorporated into the modules. Automatic physical and electrical inspection is provided for in the production line.

The MPE system is based on the use of bulk or semiprocessed materials, and the line produces all the large-quantity parts except for the tubes. The pilot plant is designed for a production goal of 1,000 modules per hour. Joining modules together to form subassemblies may also be accomplished by machines.

PROJECT TINKERTOY was sponsored by the Industrial Planning Division of the Navy Bureau of Aeronautics as an industrial preparedness measure. One of the serious bottlenecks in emergency periods has turned out to be the production of electronic equipment, upon which the military services are increasingly dependent for success in modern defense. PROJECT TINKERTOY indicates that lead time in production can be reduced 75 percent.

Modular Design of Electronics

MDE is the basis for the PROJECT TINKERTOY system. In such a system, flexibility of the product and the general characteristics of conventional assembly methods are compatibly combined. At the same time, product standardization and uniformity—the prerequisites for economical processing by automatic machinery—are integral aspects of the system. Interconnection is relatively simple between any number of modular units. By combining modular assemblies containing different component parts (resistors, capacitors, coils, etc.) whole electronic circuits may be developed to amplify signals, generate and shape wave forms, scale count, and perform customary electronic functions.

The MDE design system dispenses with the conventional circuit diagram of the tested electronic model and places all necessary production programming information on an MDE work sheet. Each work sheet contains the front and back outlines of six wafers with appropriate numbering to identify each notch in the wafer, each riser wire, and the electronic piece that is to be placed on the wafer. The engineer translates his conventional wiring diagram to an MDE diagram. He indicates the position of the piece and its proper value and tolerances. Lines are drawn to indicate how the circuits between wafers are to be connected.

The engineer's MDE work sheet becomes the basic document from which a draftsman draws an ink drawing that may be reproduced in large numbers. The draftsman also prepares a larger version of the work sheet that is photographed and is subsequently used to make stencils for the circuit printing machines. The numbers of wafers and the tube sockets listed on the MDE work sheets give an indication of the quantity of raw ceramic materials that must be mixed. The number and value of resistors marked on the work sheets determine the production required for tape resistors.

The MDE work sheet is also used to establish the inspection procedure. Current paths on each wafer are marked on specially prepared punch cards. These cards accompany the wafers through all of the manufacturing processes. The sheet is also used in the construction of the standard modules or counterparts that are employed in the final testing and inspection of the module assembly.

Mechanized Production of Electronics

MPE consists of the mechanized production of ceramic wafers, titanate capacitors and tape resistors and their automatic mechanical assembly and inspection. In some military equipment a single chassis may have as many as 100 resistors and 100 capacitors. The facilities of the NBS PROJECT TINKERTOY plant provide for the manufacture of nearly all of these pieces from raw materials.

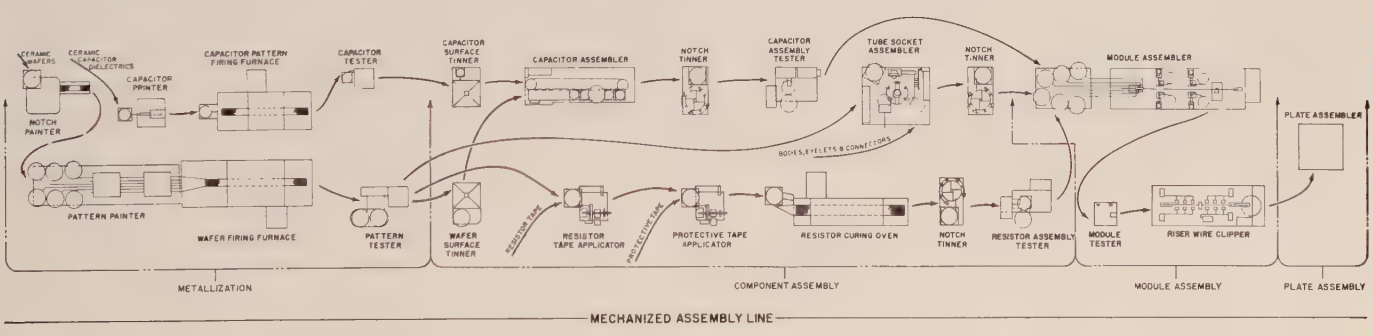
Steatite wafers and tube sockets are processed from raw materials and are stamped out at a rate of about 2800 pieces per hour. These parts are cured at 2300°F in a tunnel kiln. The wafers are then mechanically gaged, and all pieces which do not fit within close tolerances are rejected.

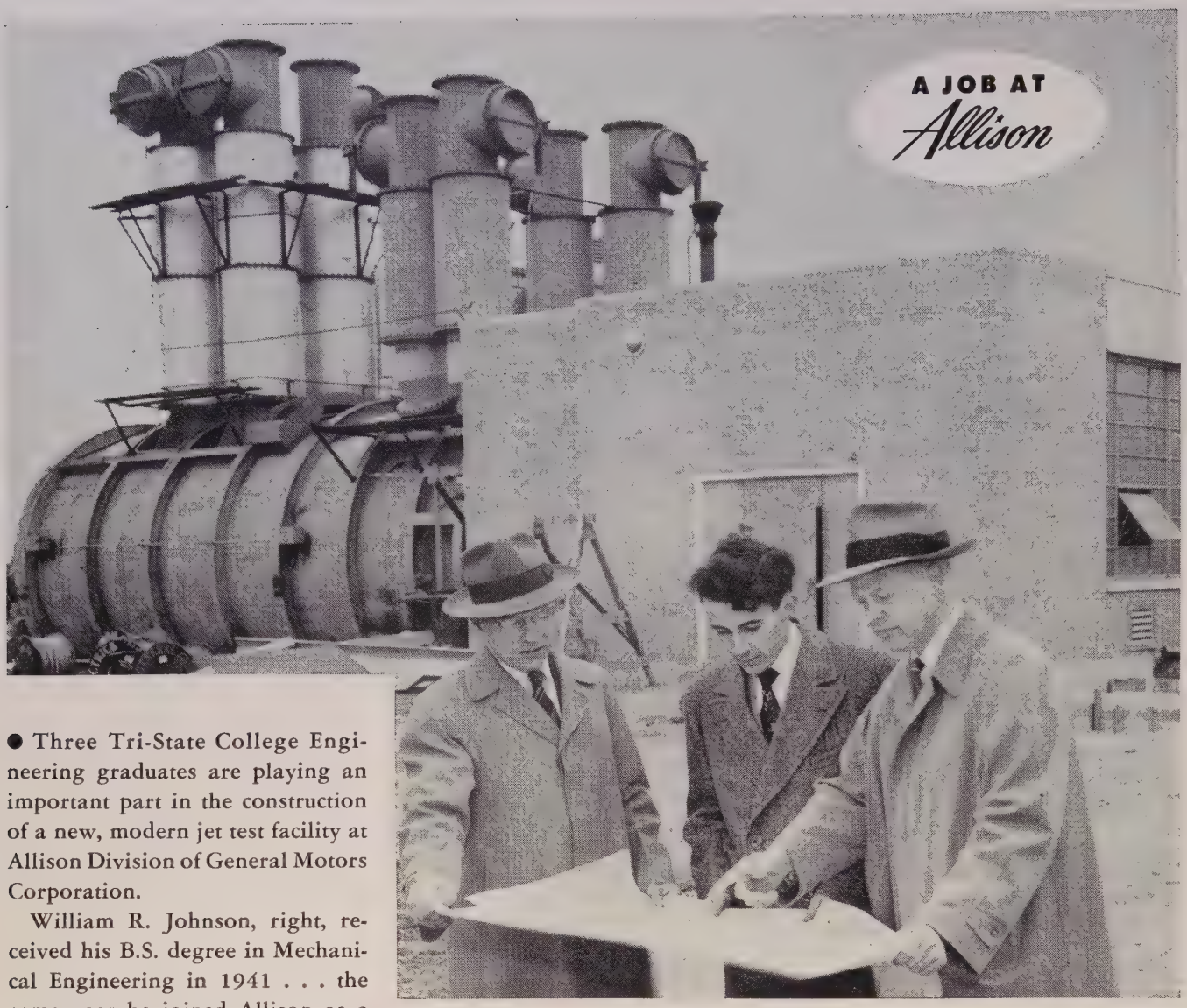
Inspection of pattern-printed wafers.

The standard wafer is pressed with twelve peripheral notches (three on a side) and a keying notch on one side. In the final module assembly, riser wires are mechanically soldered into the twelve notches and serve as physical supports for the module and electrical connectors between wafer-mounted circuits. The keying notch is a medium by which individual wafers are automatically oriented for the mechanical application of component parts.

The titanate capacitor body is manufactured in PROJECT TINKERTOY in very much the same manner as the ceramic wafers. The capacitor is nonporous ceramic composed usually of magnesium, barium, calcium, and strontium titanates of high purity, organic binders and water. After firing, it is about 1/2 inch square and 2/100 inch thick. The capacity values may be varied from 7.0 micromicrofarads to 0.01 microfarad by changing the relative proportions of the constituent minerals. Raw material batches weighing about five pounds will produce about 100,000 capacitors.

The materials required for the manufacture of tape resistors in PROJECT TINKERTOY are a heat-resistant asbestos paper tape known as Quinterra, polyethylene tape, carbon black or graphite, resin, and a solvent. The resistor formulation (a mixture of the carbon,





● Three Tri-State College Engineering graduates are playing an important part in the construction of a new, modern jet test facility at Allison Division of General Motors Corporation.

William R. Johnson, right, received his B.S. degree in Mechanical Engineering in 1941 . . . the same year he joined Allison as a junior test engineer. In 1952, after several promotions and a period in military Service, he became an engineering supervisor and was assigned the responsibility of engineering the eight jet engine test cells at the new experimental plant. The new test cells—revolutionary in design—make use of huge 100-ton steel tanks calculated to withstand an ultimate internal pressure of 175 PSIG.

H. F. Prang, left, was graduated in '42 with a B.S. in Mechanical Engineering. Later, he joined Allison as a draftsman in connection with the development of sleeve type bearings for aircraft engines. From the beginning of the new test plant program, he has been supervisor of drafting in the "Experimental Jet Facilities Group" which provides all designs of test equipment in the building.

Edward G. Delaney, center, received his B.S. in Mechanical Engineering in 1951. He was recently promoted to the "Test Projects Control Group" at Allison. His job will be to use the new equipment and facilities in the testing of jet engines. He will be running individual tests on components, and coordinating proper control installations on experimental engines.

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resin, and solvent) is ground to a fine adhesive powder. The compound is then sprayed on a loop of Quinterra tape, and a protective coating of polyethylene tape is applied. The tape is slit into five or six narrow strips and stored on rolls in a refrigerator. A 75-foot roll of tape will produce over 10,000 resistors. The tape resistors produced have a range from 10 ohms to 10 megohms. They will hold their rated resistance within ± 10 percent up to temperatures near 200°F and are capable of 1/4-watt power dissipation at the operating temperature.

Metallizing is the name given to a series of operations in the PROJECT TINKERTOY plant in which appropriate sections of the wafer or capacitor body are silver painted. During these stages, circuits are printed on the wafers, notches are coated, conducting surfaces and leads are applied to capacitors, furnace-curing takes place, and circuits are inspected. Finally, all silvered surfaces received a thin coating of solder. All of the operations are mechanized.

The keying notch pressed into each wafer is initially used during the metallizing operations. The wafers are loaded into vibratory bowl feeders provided with spiral escape channels. A series of four exit ports followed by steps are set into the channels. A small screw is inserted into each exit port that permits only those wafers to pass if the key is aligned with the screw. If the wafer is incerrectly oriented, it is turned 90 degrees as it falls down the channel step following the exit port. A specially grooved channel inverts the wafer if it has failed to pass through the other four ports, and the keying procedure is repeated. As a consequence, all wafers passing from the feeders are oriented in the same direction and have the same surface turned upward.

Another feature of the vibratory bowl feeders is the mechanism that controls the quantity of wafers being issued. The issuing channel is provided with a photoelectric cell that functions only if the light path is completed. If the channel is not filled with wafers, the completed photocell light path energizes the circuit causing the bowl to vibrate. When the channel is full, the bowl automatically stops vibrating, and, therefore, issuing wafers.

Tape resistors, titanate capacitors, tube sockets ,and other miniaturized parts are mounted on the wafers between the appropriate silvered conducting patterns. Rolls of resistor tape are placed on a machine that automatically cuts the tape into one-half inch lengths, presses the resistors between printed electrodes on the surface of the wafer, applies pressure, and eqects the completed resistor-mounted wafer. As many as two resistor tapes may be applied to each wafer surface.

A single machine is used to mount up to two capacitors on each surface of a wafer. Each capacitor is automatically oriented and the silvered circuit on both surfaces is electrically tested before mounting. For example, if four capacitors are to be mounted on a wafer, the first two are dropped into a conveyor driven jig. They are followed by a slave that centers the capacitors, and the properly oriented wafer is added. The remaining two capacitors are dropped on top of the wafer. The jig is conveyed through a pair of induction heaters that cause the tinned surfaces on the parts to bond.

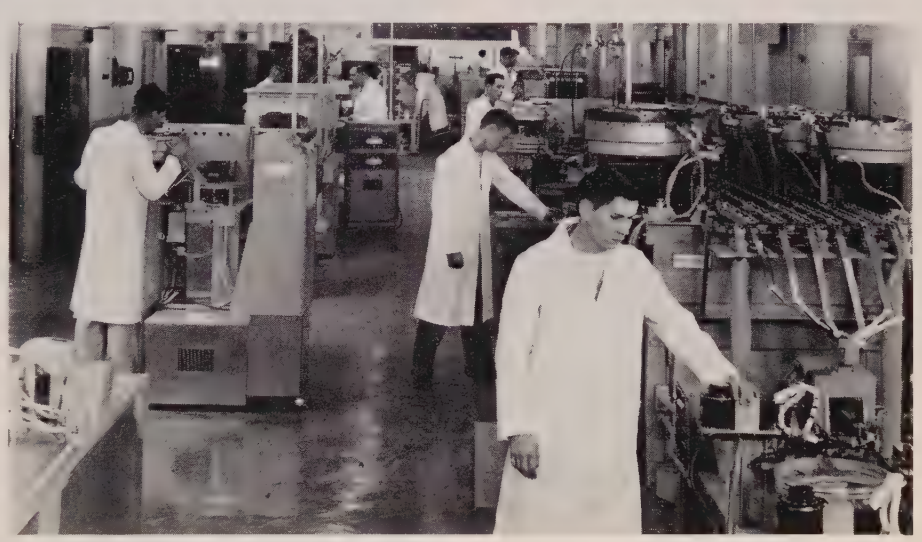
In the tube socket assembler, silvered tube pins are mechanically placed into their proper holes in the steatite tube socket, a wafer is placed on top of the socket, and a rivet binds the two pieces together.

After the various parts have been mounted on the wafers, the notches on wafer are tinned with solder. The machine that performs this operation automatically grips each component-mounted wafer and dips one side into flux and solder. The tinning operation is repeated on the other three sides after successive 90 degree-turns of the wafer.

Uniform wafer-mounted component parts, including wafer-mounted coils, toroids, potentiometers, and crystals are now ready for assembly. The complete assembly of the module is accomplished in a single machine. Six vibratory feeders issue the wafers to a loading device that holds the wafers in an upright position between specially designed jaws. A chain drive carries the jig to a soldering position at which six riser wires are guided into appropriate notches, three on a side. Th emechanism brings soldering irons in contact with the unit and bonds the wires to the notches. The unit is turned 90 degrees, and the chain drive carries it to another soldering position where six more wires are bonded to the module. After final electrical inspection, segments of riser wires are severed where circuit isolation is required between wafer-mounted circuits.

During each stage in the mechanized production of electronics, provision is made for 100-percent automatic inspection. This is both a physical gaging and an electrical comparison. Printed circuits, resistors, and capacitors are compared with their electronic equivalents both before and after assembly. This is accomplished by use of electronic computers, bridge circuits, and other comparison devices. The inspection "code" is contained on the punched cards which were prepared by the design engineer and have accompanied the wafers all through the production process. After the final assembly of the module the whole circuit is again tested to see that it meets specifications within set tolerances.

The final assembly operation need not necessarily be considered a part of the Mechanized Production of Electronics. Normally, a set of modules (as many as ten) are mounted on or between copper-clad base plates. Circuits have been etched into the copper surface and connect the riser wires of the several modules to form a complete electronic circuit. Several such plate assemblies may form an equipment. One base plate with six modules, for instance, contains all the necessary circuits to make a six-tube radio receiver function properly.

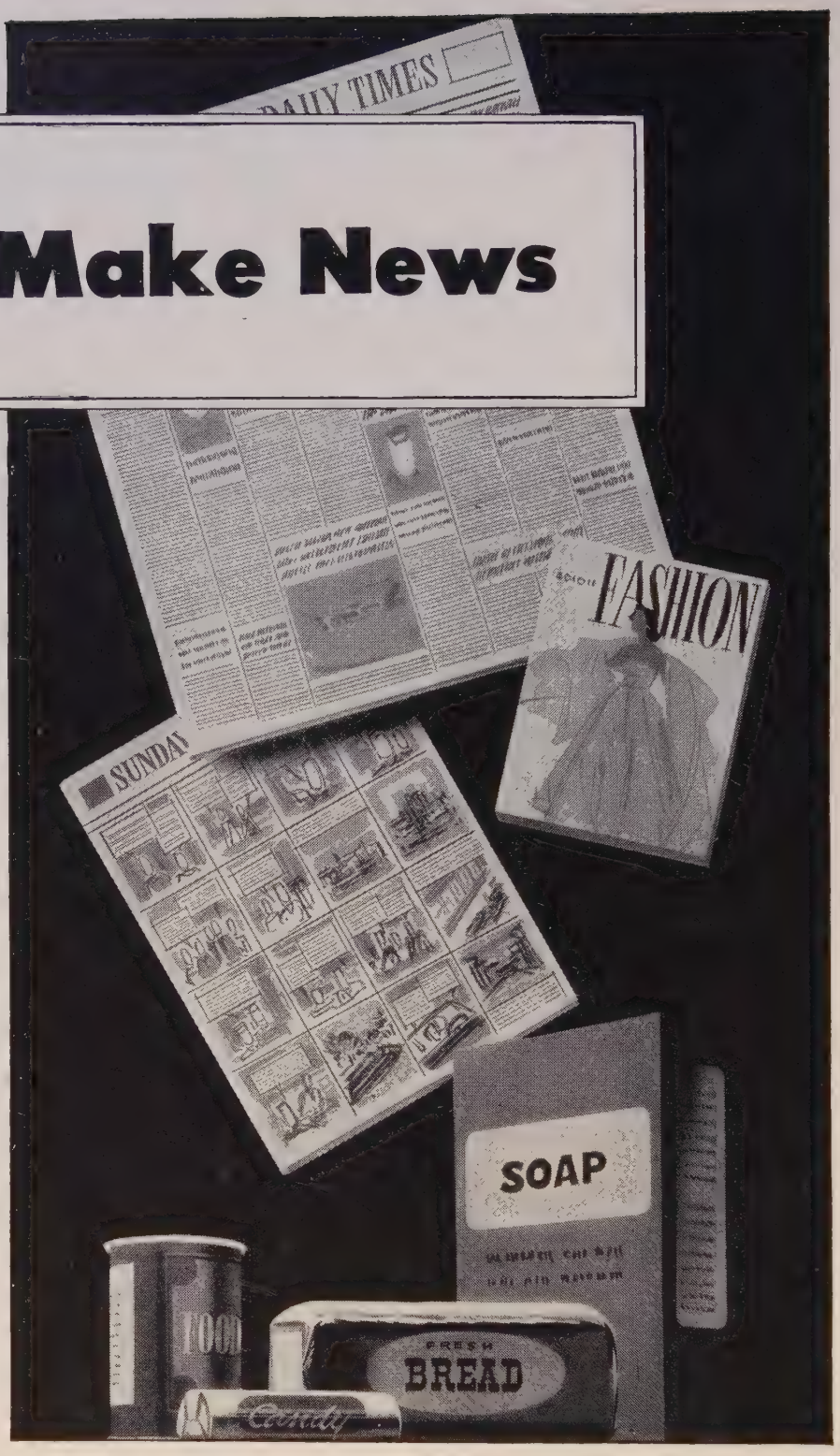


Inter of the PROJECT TINKERTOY pilot plant, conceived and developed by the National Bureau of Standards.

Industrial Preparedness

Industrial mobilization and preparedness have been studied by the Industrial Planning Division of the Navy Bureau of Aeronautics for many years. In study-

Resins Make News



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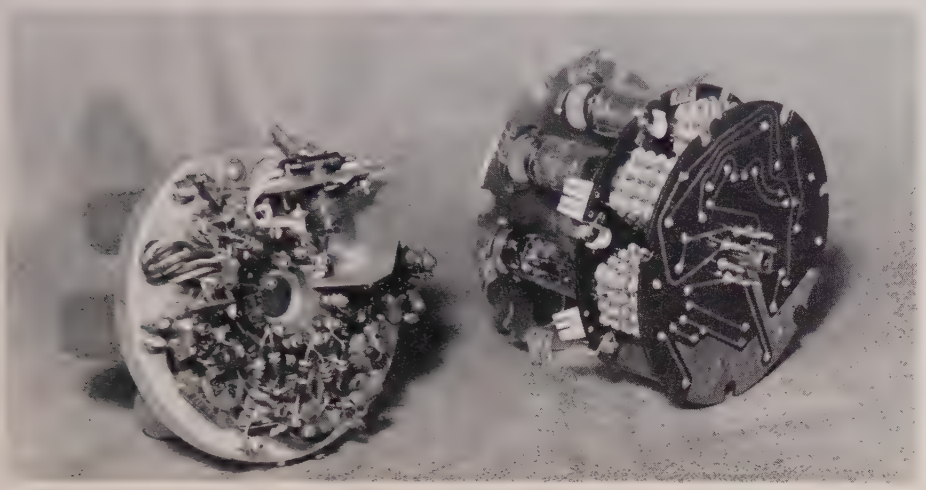
ing the electronic industry it was concluded that in the event of a national emergency costs for production and maintenance of electronics would be formidable in view of the quantities and varieties of needed gear. Consequently the Navy Burea uof Aeronautics decided that the only solution to the problems of satisfying the huge demands for electronic equipment was a mechanized production system.

The Navy turned to the National Bureau of Standards in 1950 for the solution of these industrial mobilization problems. The National Bureau of Standards had engaged in pioneering work in printed electronic circuits, stemming from problems arising in its proximity fuze work during World War II. Priror to 1950, the Bureau had developed a modular design concept, tape resistors, special circuit printing techniques, and hand-machines for printed circuits in connection with various research and development projects. Problems of miniaturization and ruggedization of electronic equipment had also been under study for some time.



Electronic equipment produced by conventional methods (left) and an MPE version of the same piece of equipment.

The first modular design of military electronic equipment had been completed by NBS in 1949, when a radar intermediate frequency assembly had been designed and constructed. A careful study by the Navy in 1950 indicated that "the most advanced state of processed circuitry is available at the National Bureau of Standards." The NBS system was particularly compatible with military environmental requirements, and constructed by the Navy in 1950 indicated that "the most advanced state of processed circuitry is available at the Naional Burau of Standards." The NBS system was particularly compatible with military environmental requirements, and stressed maximum use of raw materials rather than pre-processed component parts. The major objective of the program became the design and construction of a pilot plant compatible with the principles of Modular Design of Electronics.

PROJECT TINKERTOY makes possible a rapid conversion from civilian to military products (and back again) on short notice and, concurrently, allows a greatly expanded production capacity. Delays caused by the need for recruiting and training new production personnel and the procurement of new mechanisms and parts are eliminated. Most of the operating "know-how" is stored in mechanical fingers and electromechanical control mechanisms, and even electronic equipment designs may be stored, ready for production, in the form of punched cards and circuit stencil screens.

Because PROJECT TINKERTOY largely utilizes unprocessed or bulk materials, the system is comparatively free from dependence on particular components in critical supply. The Mechanized Production of Electronics results in a very high production rate. Uniformity of electronic products at a high quality level is enhanced by the mechanized production and by 100% automatic inspection. This affords the possibility of repair and maintenance of electronic systems by replacement of untized packages or entire subassemblies.

Performance of equipments produced in PROJECT TINKERTOY appears generally equivalent to that obtainable from conventional assemblies. Equipments produced on an experimental basis meet military environmental requirements, passing such tests as shock, vibration, temperature, and humidity established in military specifications. Moreover, the standardization and uniformity achieved by the MDE wafer-component and stacked-wafer design result in production outputs of uniformally satisfactory equipment, whose characteristics both physically and electrically are carefully controlled through the 100%-automatic inspection machines that are an integral part of the production line.

The final design and subsequent construction of many PROJECT TINKERTOY machines called for the services and assistance of industry at a time when the Korean emergency had preempted most machine-tool and related facilities. The Navy and the National Bureau of Standards were able, however, to secure the cooperation of several companies with available facilities and staff.

Basic conception and development—as well as early background research—were contributed by the National Bureau of Standards, including solution of new process and materials handling problems, design of the pilot plant and much of its equipment, and technical direction of all phases of the program. While some of the plant machines were designed and constructed by NBS, the major part of the design and construction of the production equipment was done by the Kaiser Electronics Division of Willys Motor Co. Some special machines were also designed and built by the Doughnut Corp. of America (Ellicott City, Md.). Specially designed automatic production test equipment was obtained principally from Communication Measurements Laboratory, Inc. (Plainfield, N. J.). Some major engineering applications to equipment were made by Sanders Associates, Inc. (Nashua, N. H.), including environmental studies of MDE units. The Davies Laboratories (Riverdale, Md.) and the Navy Post Graduate School (Monterey, Calif) also rendered assistance in some phases of the work. Acknowledgment is also due to many companies and individuals who contributed auxiliary services and supplies.

"I see you're driving a new car."

"Yes, I tried to sell an insurance policy to an automobile salesman."

* * *

An old-timer is a fellow who remembers when he could buy a pound of steak for a dime, but forgets he had to work an hour to earn the dime.

* * *

A smart girl is one who quits playing ball after one good catch.

* * *

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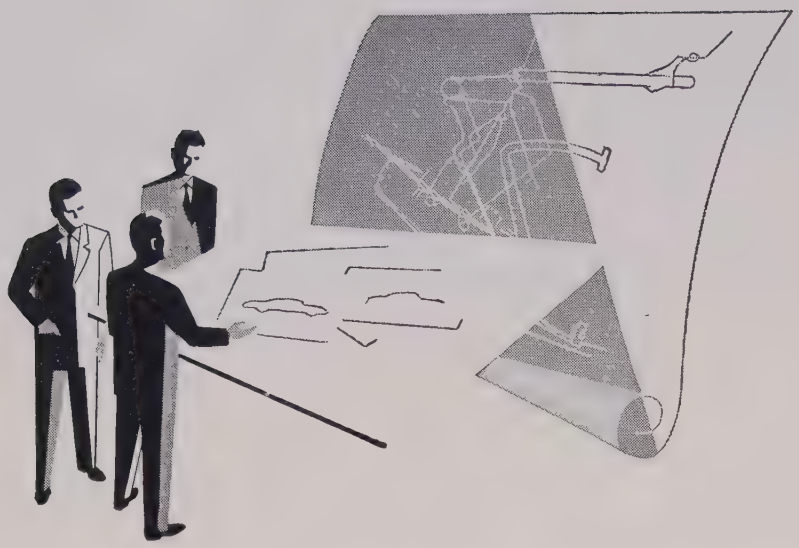
* * *

Arguing with a woman is like trying to read a newspaper in a high wind.

* * *

If most women had it to do over, they'd marry the man they didn't have to do over.



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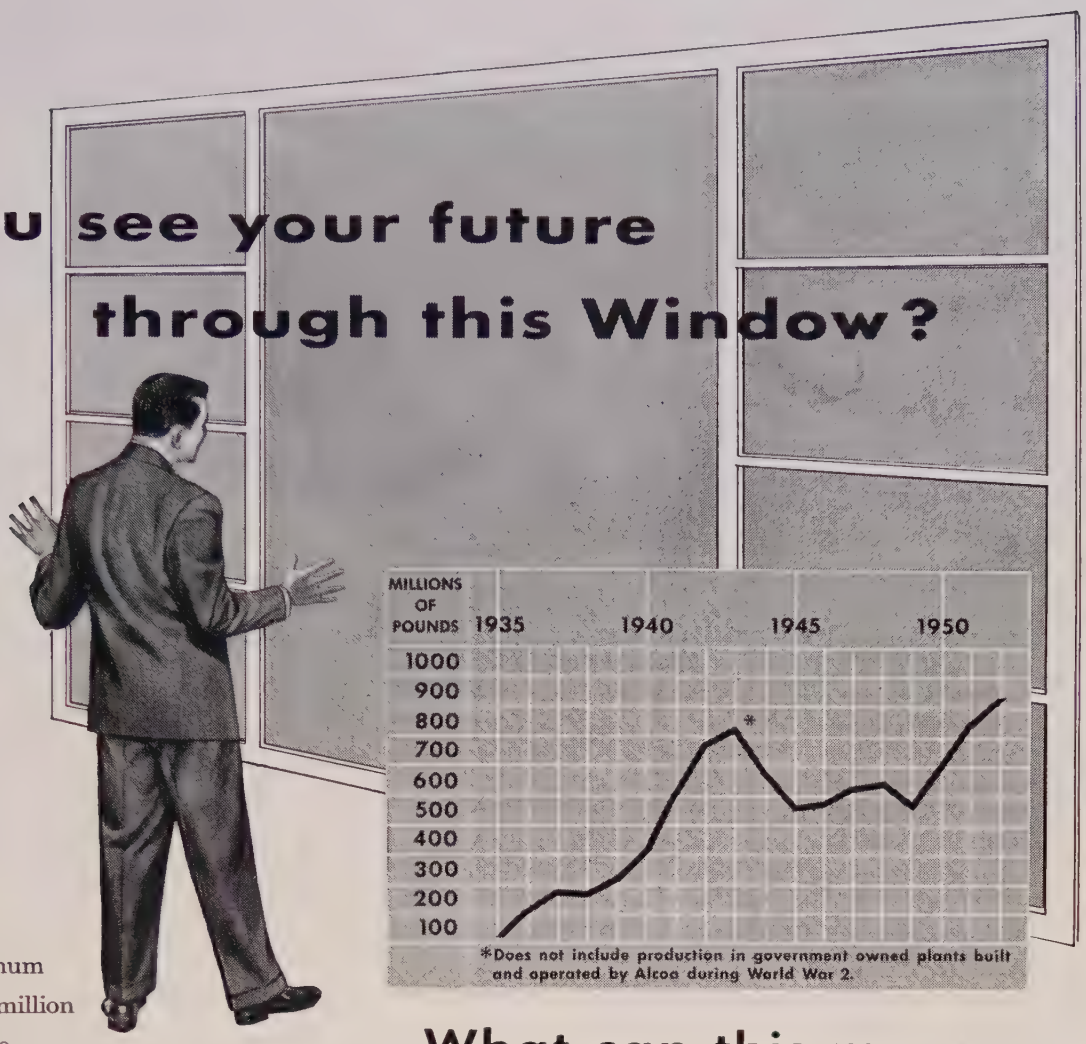

This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

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CHANCES ARE . . .

by Don Arnold, E.E. '55

Have you been gambling lately? When was the last time you walked across the street? That was really taking a chance that a car wouldn't turn a corner and run you down. Sure, we've all been gambling many times a day and on the simplest forms of everyday life.

Even if all of us do not have a close relation with the more recognized forms of gambling, occurences always turn up in which one of us is trying our new formula to try to beat the roulette table.

In November of 1947, two University of Chicago students rode out to Reno, Nevada, in an old beat-up car with $120 in their pockets. These students had figured a way to beat the wheel through a progressive parlay based on mathematical probability and two basic assumptions: (1) that any roulette wheel has some slight imperfection and follows a pattern of its own, and (2) that good or bad luck runs in streams. Night after night, anyone could see one of this partnership sitting by the roulette wheel feverishly taking down the winning numbers. Finally, they risked their first bet, using a system of increasing bets in a run of good luck but never decreasing bets. Before their streak of bad luck became prolonged, these two ran their $120 into $7,500. Here, they made the smartest play of their gambling career and went back to Chicago ahead by over $7,000.

This is just one lucky case of many who have tried to break the bank at the gambling halls. Not all stories have such a happy ending, and we are not trying to influence you to perfect a formula to beat the wheel. However, we would like to show some of the basis for the odds that you may read in the morning paper or to show you just what are your chances of beating the roulette wheel or some other gambling device.

Most odds are based on the simple laws of probability. For instance, if you have 3 pairs of trousers, 4 shirts, 2 pairs of shoes, and 2 sport coats, how many different ways can you dress. If you would try to figure out all of the different combinations, you would find that the answer is merely the product of the respective numbers, or 3 x 4 x 2 x 2, or 48 different combinations.

The same general principle would hold if you were giving odds on the chance of rolling a certain number on a pair of dice, say a 12. The chance of rolling a 6 on either die is one out of 6. Putting these two probabilities together, we have 1 out of 36, or 35 losses against 1 win. Thus the odds would be 35 to 1. Of course, if there is more than one combination of the dice that will give a number, the odds are greatly reduced. The odds against rolling a 7 on a pair of dice, for instance, are 5 to 1.

Have you been playing any cards over at your house lately? Well, the odds are 1 to 3 that you bought a deck of playing cards this year, and the odds are 2 to 1 that you will be playing bridge with them. If in this game of bridge, you and your partner hold 7 trump, you'll get an even split 36% of the time; if you hold 9 trump, you will get that even split 40% of the time; with 11 trump, you will get it 52% of the time.

If you have been betting on the football pools, you had better pick your teams carefully, because the odds are against you. Your chances of picking three winners are 2 x 2 x 2, or 1 out of 6, while the cards give you 5 to 1. The chances of picking 10 out of 10 football winners are 1023 to 1, but you get odds of only 100 to 1.

Every spring the Kentucky Derby is run, and every race has its perennial favorite. Contrary to common belief, the bookmaker or race track does not set the odds on the horses, but the betters themselves cut their own throats through a system called parimutuals. Here the bettors make their own odds, and the race track takes a certain percentage of the total amount that is bet. Of course the state also takes its share of the bet so that less than 85% of the money bet on each race is returned. Hence, if a bettor would start with $10 and only get his 85% back on every race of an eight race card, he would only have $2.70 left at the end of the day.

According to the pari-mutual system, if $100,000 is bet on a race, the track and state take about $15,000. Now if 10,000 tickets were sold on this winning horse, each ticket would pay $\frac{\$85,000}{\$10,000}$ or $8.50. The odds are a little more complicated in computing the place (second) price, as two winners must be payed. Say that after the track and state has deducted its 15%, the total amount to be paid back to the bettors is $100,000. Thus $50,000 would be paid to the holders of tickets on the two winning horses. If 20,000 tickets are sold on one horse and 10,000 tickets on the other, the two tickets would be $2.50 and $5.00 respectively. The same system is used no matter how many winners are to be paid off.

As you can see the track doesn't care which horse wins the race because it always gets its same percentage and always wins. That is unless the minus pool is encountered. This is the situation that occurred nearly every time Native Dancer has run. The law requires that at least $0.05 must be paid back on each dollar bet on the winning horse. Thus in a hypothetical case let us say that out of the $100,000 bet on all horses in the race, $90,000 of it is bet on our winner, Native Dancer. If the state takes an eight per cent cut of the total amount bet, this would only leave $92,000 to be distributed to the winners. Since the track must pay back at least $1.05 for every dollar bet on the winner, a total of $94,500 must be paid back to the bettors, and the track must accept a loss of $2,500 on the race.

But what were the chances of our two University of Chicago students' beating the roulette wheel? The owner of the Monte Carlo Casino and the most played-on roulette wheel in the world said about the game, "Red wins sometimes; black wins sometimes; but white (the house) wins always."

A normal roulette wheel has 36 numbers and one zero. Of these 36 numbers, 18 are black and 18 are red. A player can wager that any certain number will

come up or that the winning number will be either red or black. The odds that any one of the 36 numbers (there are actually 37 spaces) will turn up is 1 out of 37, but the odds given are 35 to 1. The odds on one of the colors coming up are given at 1 to 1 when they are really 37 to 36 against your picking the right color. This means that for every $100 bet on a number at odds of 35 to 1, you can expect to get $97.30 back.

But these wheels are merely man-made instruments and every one must eventually have some minute flaw that will cause the wheel to spin untrue. It is on these repetitions that most of the gambling systems are based. This is why you can see the system player sitting by the roulette table with his notebook in hand trying to find the flaw that will show him he magic number that will defy the so-called law of averages and and appear more than the rest of the numbers.

There are many types of systems used by gamblers to apply the laws of probabilities to beat the roulette wheels. One known as the Martingale is to bet on a color and keep increasing the bet when losing so that when he finally wins, the winnings will more than cover all the losses. For instance, a player could bet one dollar on the red. If he loses, his next bet would be two dollars, and then four dollars, and eight dollars, and on up until he finally wins. Thus, if he wins on the fourth bet, he would receive $8, while he had lost a total of $7 on the three previous bets.

One of the big disadvantages of the Martingale is the limit set by the bank. If the player encounters a long run of losses, his progressive bets may reach the limit set by the house. Thus he suffers the maximum loss equal to the betting limit, and a series of maximum losses spaced close together will not give him time to recoup his losses.

Another system of this type is known as the Great Martingale. The bets after successive losses in this system are one less than the power of 2, or 1, 3, 7, 15, 31, 63, . . .

The effect of the zero in the Martingale is that it tends to increase the chance of an unfavorable run. To offset this additional strain, some players put a side bet on the zero. If no win is encountered by the fifth bet, the player would bet $1 on the zero while betting the usual $16 on, let us say, the red. If the zero would come up on this play, he would win $35, but will have lost $31 on the Martingale. If however, the black would appear on the fourth play, the player would increase his bet on the zero to perhaps $2, while his bet on the red would by the system increase to $32. Now if the zero would appear, he would still win a total of $7 on the series. If the red would come up on this sixth bet, he would be $1 out for the series and well able to start again. However, if the black would have come up again, the player must again increase both of his bets so that if he encounters a win, he can start again with little or no loss.

All of the basic systems are based on a combination of many of these principles, but there is one and only one system of play that most surely leads to winning even though the proceeds may be small. The kernel of this system depends upon finding a dishonest wheel. If you discover one that is being manipulated, it will surely be set so that the large bets will be lost. This is the time to bet opposite the large bets, and you are certain to win.

All of the odds stated depend upon a completely unbiased wheel which is mechanically perfect. But if the apparatus is defective, these odds cease to be true. If the machine so operates that its variation from the laws of chance are sufficient, a system may be worked out in which the odds of the game desert the bank and switch over to the player. It is this for which our notebook players and the two University of Chicago students are looking. So, engineers, whip out your slide rules, dust off your integral tables, interolate those logarithms, and chances are. . . .

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TECHNICAL WRITING GROWS INTO NEW PROFESSION

Publications Engineering

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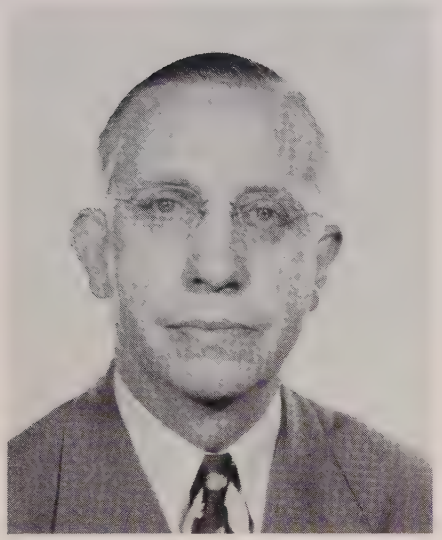


Robert T. Hamlett received his B.S. in Electrical Engineering from the University in 1928. His present paper first appeared in the "Proceedings of the I.R.E." for October 1952.

Summary—Engineering-level technical writing is described as requiring, foremost, the skills and knowledge of an engineer and, secondly, the ability to write well. For this combination of work the term "Publications Engineer" is proposed. The writer's participation in an engineering project is outlined on a time basis, starting with the sources of information and completed with delivery of the printed work. Satisfying aspects of the field are discussed and the future is predicted as of growing value to the engineering profession as a whole.

Introduction

The tremendous expansion in the size and productiveness of the engineering profession has been due, in a large measure, to the ability of research and development engineers to enlist other engineers for special tasks or services related to their basic problems. It was not so many years ago that an *engineer* was *the engineer*—he was charged with responsibility for all *engineering* work on a project. This was possible because the end result of his engineering work was usually a single unit or instrument which operated without "tie-in" or reference to other equipment. He found time somehow to solve all of the engineering problems that arose in connection with his "brain child."

But the modern era of "systems" rather than "instruments" has changed the engineering approach to a very marked degree. One hears now about systems engineers, product engineers, project engineers, standards engineers, administrative engineers, test engineers, field engineers, production engineers, packaging engineers, industrial engineers, and so on. What has happened? Simply that the individual engineer cannot any longer carry all the burdens of the job of "engineering" of a system or even of a single instrument which ties into a system. While a very gifted engineer, possessing high skill in many branches of engineering, may still be able to visualize and guide the work on his project, he is no longer able to carry on the many individual investigations, attend the frequent engineering conferences, plan the fiscal and field-testing programs, solve the production and packaging problems, or create the publications which are necessary.

This ability of the engineer to pass on responsibility to other engineers has given rise to still another field of specialization within the engineering profession—that of TECHNICAL WRITING. (See Fig. 1.) The products of this new field are instruction books, training manuals, engineering reports, technical data sheets, and many other types of technical information, a sampling of which appears in Fig. 2. The workers in this field are referred to as "Technical Writers," "Engineering Writers," "Specification Writers," "Technical Report Writers," and the like. This author prefers to call the workers in this field "Publications Engineers," in keeping with other well-established titles such as "Standards Engineer," "Test Engineer," and "Field Service Engineer." This new title will be used throughout the article.

What Is a Publications Engineer?

The principal reason why this author prefers the new title "Publications Engineer" to that of "Technical Writer" is that it more clearly designates the duties of such a worker, and also places him in a proper professional status with fellow engineers, where he rightly belongs. For he is an engineer first, and secondly a writer. The term "Technical Writer," as commonly accepted, refers to a writer who writes material on technical subjects to various levels of intelligence but who is not usually concerned with the actual publication processes and problems.

The Publications Engineer is an engineering specialist who relieves other engineers of the major portion of the responsibility for production of all publications required as a result of the engineers' work. The Publications Engineer writes technical material, plans and directs preparation of copy, and carries through on all details concerned with actual production of the publication. It is necessary to repeat that he is first an engineer, then a writer, and finally, a publication man.

Engineers have always labored under the stigma that they cannot write well. It is a common attitude, even in pre-college education, to assume that because

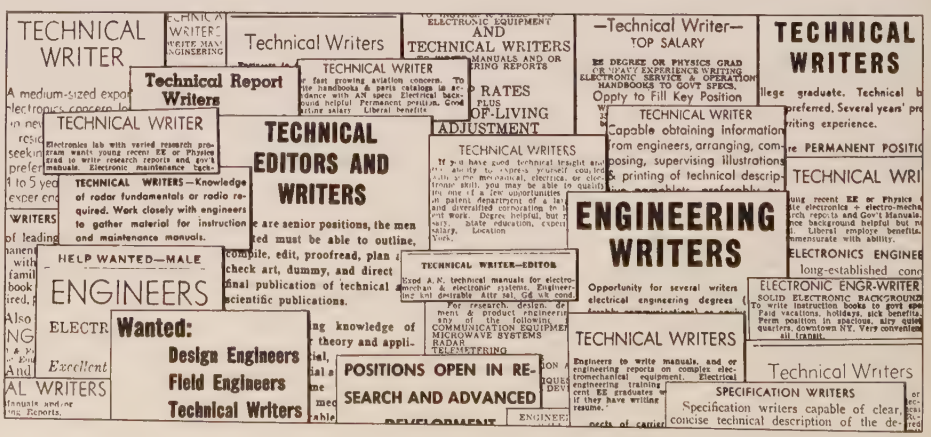


Fig. 1—Demand for engineer-writers, identified herein as publications engineers, is evidenced by these classified advertisements selected at random from employment sections of newspapers and magazines.

the student is superior in mathematics he must be inferior in English. This affects the student's attitude and he very naturally uses it as an excuse for not seriously studying the subject in which he is prejudged to be inferior. When the "superior" math student goes to engineering school, it is a foregone conclusion that there is very little that can be done to help him there. However, he is given one or possibly two courses in English (especially "arranged" for engineers) early in his college work. No further attempts are made to help him overcome a deficiency which will handicap him throughout his entire career.

There is no doubt that some engineers cannot write—but some lawyers, some accountants, and some doctors cannot write well! Some doctors do not develop a pleasing "bedside" manner, so they become fine surgeons or specialists. So some engineers do not take time to write well, and because of this other engineers now find an interesting and well-paid profession.

The Publications Engineer must be an engineer who has writing aptitude. This aptitude may have never become very obvious because of the misguidance and lack of encouragement received during his education. The author has seen many engineers, who felt certain that they were below average in writing aptitude, develop into excellent writers of technical material. No one can doubt that the engineering profession would be in a much better position if there were more effective writers among us. (The same might be said for speakers.)

The Publications Engineer must be an engineer with unquenchable thirst for learning. If he is a mechanical engineer, he must be learning more about electronics; if he is an electrical engineer, he must be learning about aerodynamics, hydraulics, and the like. He is constantly challenged to describe something about which he knows practically nothing. But with his basic engineering education under his hat, he tackles each unknown with some confidence that he can understand and interpret it for others who may know more or less about it than he does. Many fine technical descriptions result when engineers who are educated in one field begin to write on subjects in other engineering fields; they use analogies which help the reader in applying the description to his own experience.

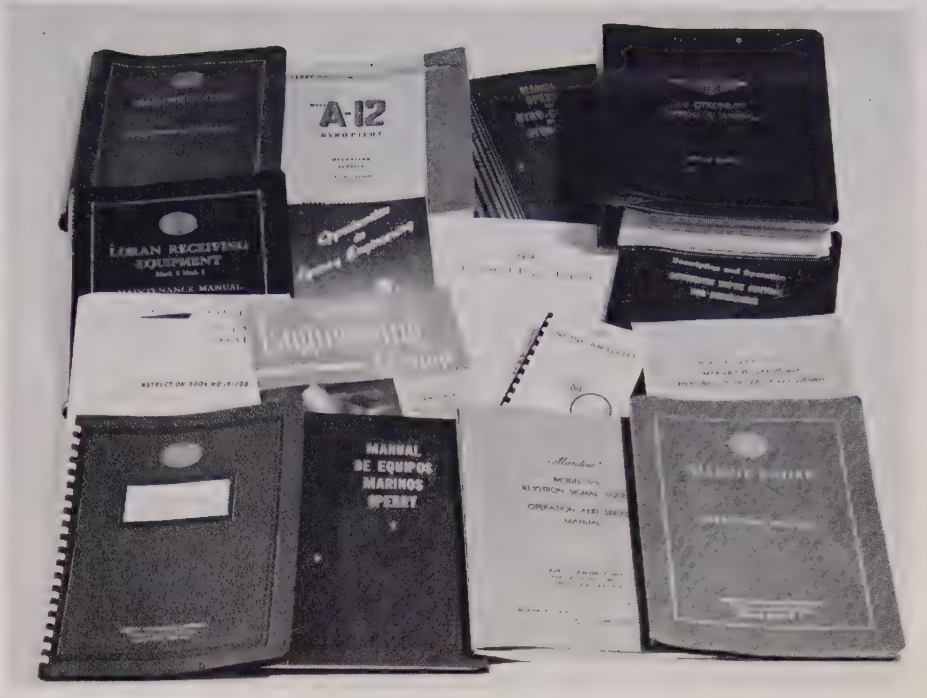


Fig. 2—Publications engineers produce a variety of matter requiring skills of both engineer and writer.

The Publications Engineer must have a working knowledge of the advantages and disadvantages of many types of reproduction processes, such as spirit duplication, mimeograph, Photostat, blueline, and blueprint, Ozalid, and offset printing and letterpress printing. He is familiar with type faces, paper stock, cover materials, binding methods, and the like. He understands the problems involved in production of copy by typewriters, Varitypers, typesetting, and phototype. He has a practical knowledge of the arts of photography and retouching, and he guides technical illustrators in visualizing and rendering special illustrations for use with his written words.

All of his talents and acquired knowledge are combined in the process of preparing a publication that must meet government or commercial specifications covering content, format, practicability, and literary standards. He is at the same time an engineer, a writing specialist, a publications expert, and a student of psychology!

When the young Publications Engineer has overcome his inferiority complex in tackling new writing projects, he finds the variety of writing assignments to be one of the most attractive features of his job. It is a familiar complaint among engineers that they become too specialized and know too little of what is taking place in the scientific world around them. While no scientist can hope to keep abreast of the tremendous evolution of technical achievements now taking place, the Publications Engineer finds real satisfaction in testing and adding to his knowledge in many different fields. As an eample, in the author's company the skilled Publications Engineer develops a descriptive knowledge in such varied fields as radar, hydraulics, servomechanisms, gyroscopics, computing mechanisms, ballistics, optics, navigation, and aerodynamics. When the occasion demands, he becomes, for a time, a writing specialist in one or more of these fields.

In addition to the variety of writing from the product standpoint, there is also much variation in the material to be gathered on any one product or system. Fig. 3 illustrates some of the writing assignments on a single system. Some of the assignments require the Publications Engineer to work intimately with the equipment; in some cases he com-

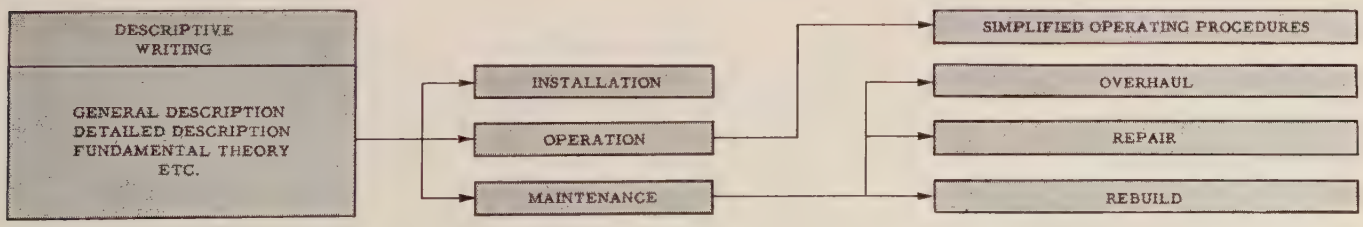
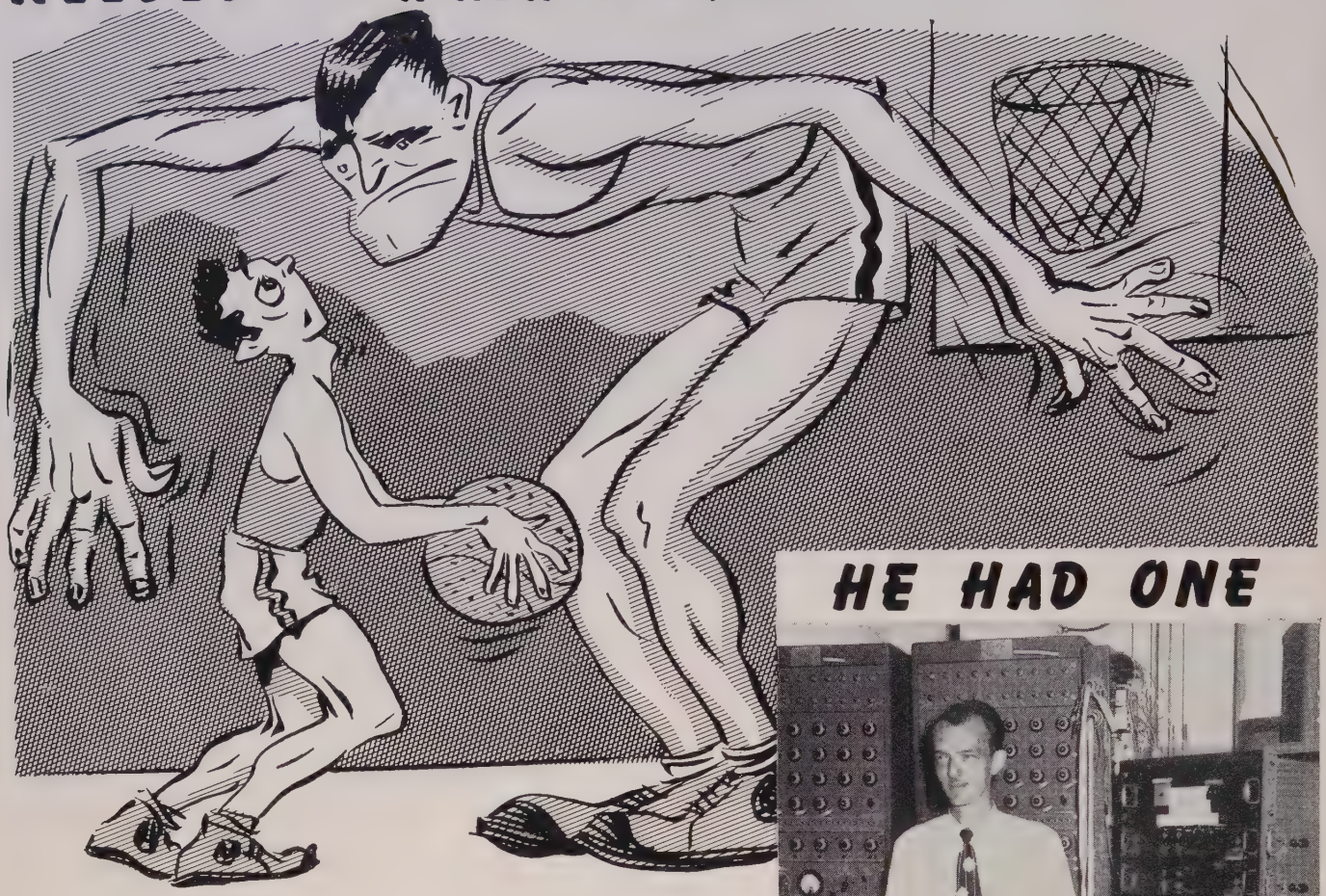


Fig. 3—Publication engineer's writing begins early with a project and follows product into the field.

NEEDED--- A NEW APPROACH!



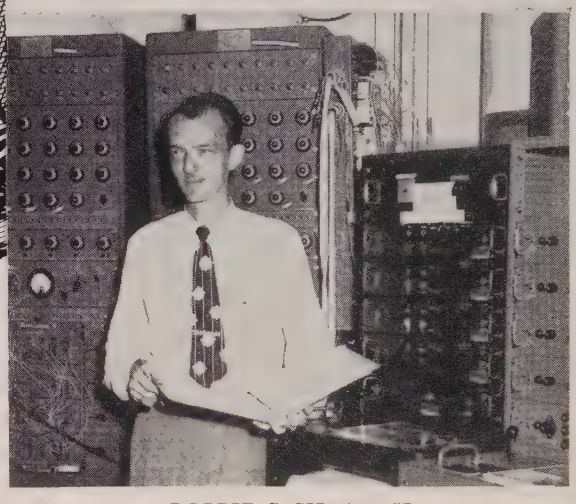
Prime contractors to our Armed Forces—M. A. C. is engaged in the design, development and production of airplanes, helicopters and guided missiles. One of the newer products of McDonnell ingenuity, the F101 Voodoo, will soon join the arsenal of the U. S. Air Force.

McDonnell engineering planners are constantly alert to new materials, new equipment and new techniques. A Flight Test Hanger, Propulsion Laboratory, Altitude Test Chamber and Wind Tunnel are recent additions to our engineering facilities. We are also interested in new engineering talent—men who can contribute original thinking—*engineers with a new approach.*

If you're looking for our type of engineering—we're looking for you. Check your Placement Office for dates when the McDonnell representative will visit your school. Ask him about the McDonnell Graduate Study Plan. You may also write to:

Technical Placement Supervisor
Box 516, St. Louis 3, Missouri

HE HAD ONE



BOBBIE S. SHARRAH
Assistant Chief Dynamics Engineer — Missile Engineering Division
B.S.A.E. Iowa State College '45
M.S. Applied Mechanics Washington University '52

Pictured in front of our REAC installation, Bob Sharrah exemplifies the type of pioneering spirit essential in missile engineering. He developed a new and useful approach to the problems of stability of guided missile control systems as influenced by aeroelastic effects. At twenty-eight, Bob also points up the youthfulness of M.A.C.'s engineering management.

If your interests lie in the field of missile development, a challenging career awaits you at McDonnell. We need more young engineers like Bob Sharrah—*engineers with a new approach.*

BUILD YOUR FUTURE WITH A COMPANY . . . . YOUNG IN YEARS, YOUNG IN SPIRIT AND IDEAS

McDONNELL *Aircraft Corporation*

pletely disassembles and reassembles the units. In other cases, he accompanies the equipment on trial runs or field tests. These experiences give a "practical" satisfaction to those who like to feel that they are not just "theoretical" wriers.

Anoher attractive feature of the Publications Engineer's work lies in the variety of contacts which he makes in the course of the development and approval of a publication. Fig. 4 shows a typical "life story" of an instruction book prepared for the Armed Services. The underlining in the diagram gives an indication of the many individuals concerned in the preparation or approval of the publication prior to its final printing; the Publications Engineer works constantly with all of those shown.

The Future for Publications Engineers

Young engineers often raise the question as to the future of Technical Writing or Publications Engineering. There are several factors which appear to be of importance in attempting to predict the future—but to the auhor they all look favorable toward increasing opportunity for this new profession. First, the complexity of equipment and systems certainly will continue to increase; automatic control is the utimate goal of nearly all future instrumentation, and with such control always comes increased technical complexity. With increasing complexity there is greater need for more complete instructional material. As one associate put it, "the equipment becomes more complex but the intelligence of the average user remains the same." Second, granted that complexity will increase, there is the immediate following condition that the equipment will be much more costly and must be repaired rather than replaced. This adds again to the need for publications which will be adequate for the purpose. The funds allocated for publications will necessarily increase, but will still be a very small portion of the total cost of the equipment. Third, if the caliber of engineering graduates coming into Publications Engineering is maintained or raised, there will be a broadening in the scope of their work since they themselves will develop opportunities for using their special skill to supplement the work of other engineers. This is a very important responsibility in any new profession—to develop and broaden the particular skills and to offer them to others.

Conclusion

Publications Engineering is a new profession which has grown rapidly in the past few years because of the increasing complexity of equipment and the inability of the research and development engineers to undertake the extensive writing projects which became necessary.

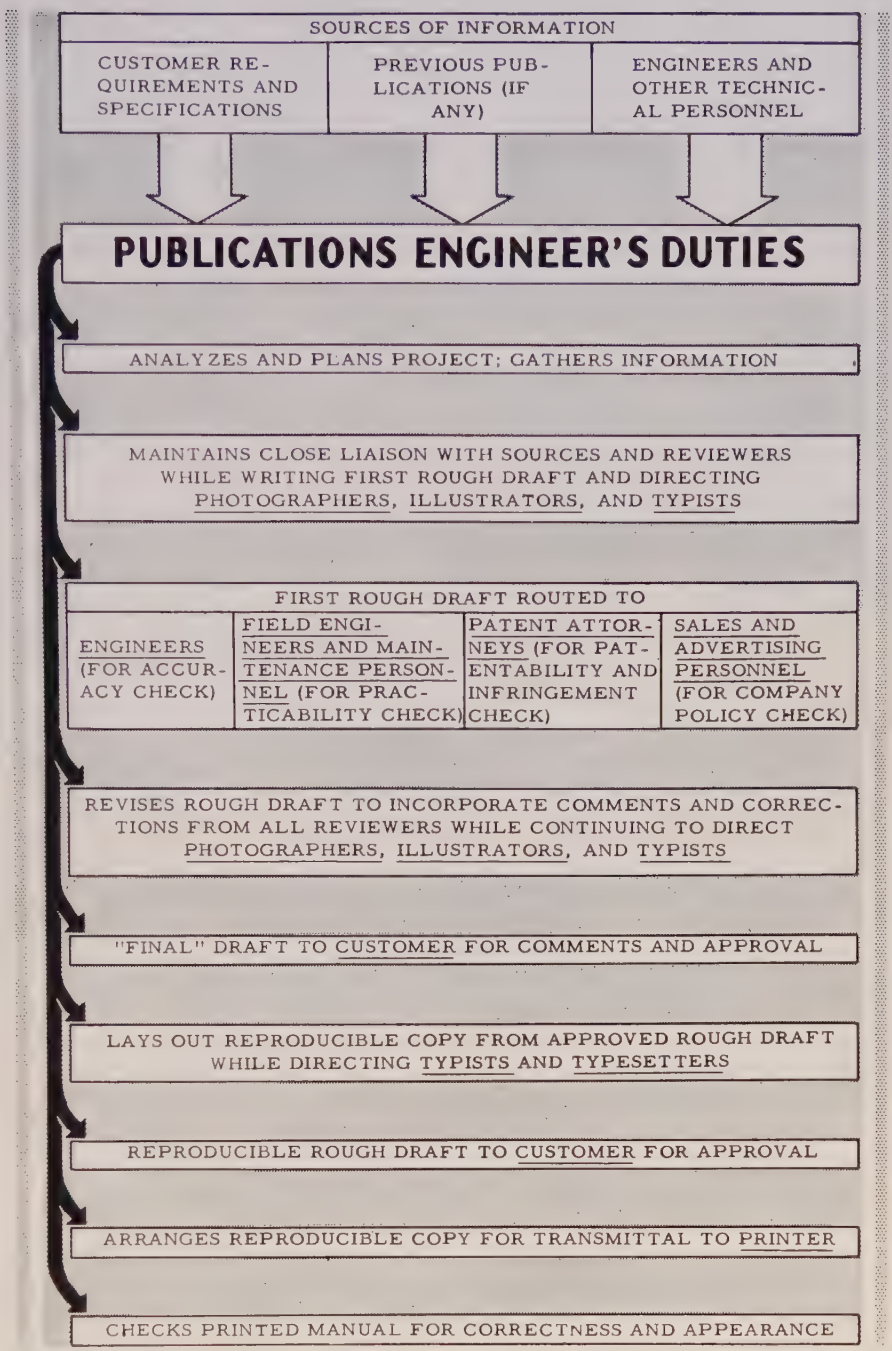

SOURCES OF INFORMATION
CUSTOMER REQUIREMENTS AND SPECIFICATIONS
PREVIOUS PUBLICATIONS (IF ANY)
ENGINEERS AND OTHER TECHNICAL PERSONNEL
PUBLICATIONS ENGINEER'S DUTIES
ANALYZES AND PLANS PROJECT; GATHERS INFORMATION
MAINTAINS CLOSE LIAISON WITH SOURCES AND REVIEWERS WHILE WRITING FIRST ROUGH DRAFT AND DIRECTING PHOTOGRAPHERS, ILLUSTRATORS, AND TYPISTS
FIRST ROUGH DRAFT ROUTED TO
ENGINEERS (FOR ACCURACY CHECK)
FIELD ENGINEERS AND MAINTENANCE PERSONNEL (FOR PRACTICABILITY CHECK)
PATENT ATTORNEYS (FOR PATENTABILITY AND INFRINGEMENT CHECK)
SALES AND ADVERTISING PERSONNEL (FOR COMPANY POLICY CHECK)
REVISES ROUGH DRAFT TO INCORPORATE COMMENTS AND CORRECTIONS FROM ALL REVIEWERS WHILE CONTINUING TO DIRECT PHOTOGRAPHERS, ILLUSTRATORS, AND TYPISTS
"FINAL" DRAFT TO CUSTOMER FOR COMMENTS AND APPROVAL
LAYS OUT REPRODUCIBLE COPY FROM APPROVED ROUGH DRAFT WHILE DIRECTING TYPISTS AND TYPESETTERS
REPRODUCIBLE ROUGH DRAFT TO CUSTOMER FOR APPROVAL
ARRANGES REPRODUCIBLE COPY FOR TRANSMITTAL TO PRINTER
CHECKS PRINTED MANUAL FOR CORRECTNESS AND APPEARANCE

Fig. 4—Publications engineer gains broad knowledge of product, its engineering, manufacture, and application. Persons with whom he consults directly are underscored in this diagram of manual's life cycle.

The Publications Engineer must have a sound engineering education and must possess writing aptitude—although it is pointed out that the possession of this aptitude may not be realized by many young engineers.

The Publications Engineer develops a knowledge of the reproduction and printing processes, and can guide the publication through all of its stages from rough draft to its printed form.

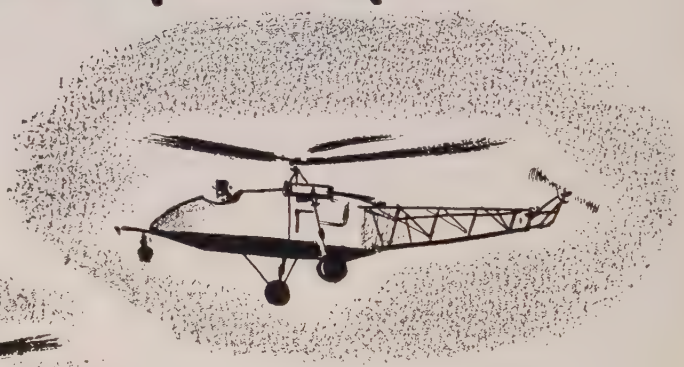
The variety of work assignments and personal contacts appeal greatly to certain engineering graduates. Some of the writing arrangements cover theoretical aspects, others are along practical lines where the writer works closely with the equipment in the factory or in the field.

The "personal-satisfaction" factor is quite high for the Publications Engineer since his assignments are usually of short duration, compared to those of the engineer, and he "sees" the final results of his labors at more frequent intervals.

Finally, the future of this new profession looks promising because of the trend towards more complex equipment and the accompanying requirements for more complete handbook and engineering report coverage. The future also depends upon the efforts which Publications Engineers make to find new areas of service to the engineering profession.

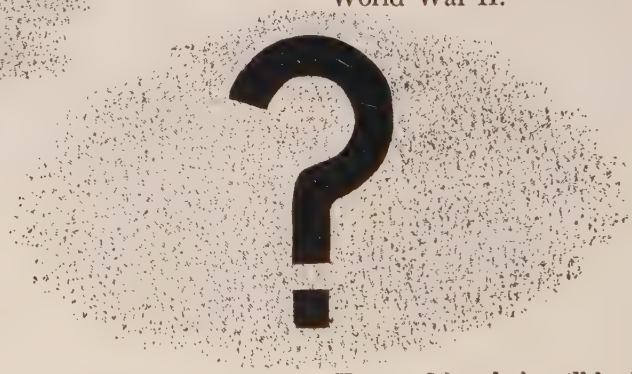
Only a few short years ago

the helicopter was thought to be a "stunt" machine — amazing and amusing, and not particularly important. Events in Korea changed that idea — fast! This fledgling among aircraft performed "impossible" military assignments, spectacularly successful missions of mercy. Helicopters came into their own.



In 1939, the VS-300 with Igor Sikorsky at the controls made the first practical helicopter flight in the United States. Hundreds of later Sikorsky's were delivered for service in World War II.

Now in demand for hundreds of jobs, today's most versatile flying machine is the product of ceaseless testing, highest-calibre engineering, work and imagination.



Future Sikorsky's will be built by tomorrow's engineers. Perhaps *you* belong at Sikorsky where your skill and ability will be continually challenged.

You might find — in Sikorsky Aircraft's research departments, drafting rooms, engineering laboratories — a lifetime opportunity in this young, growing and most interesting field of aviation. Write today to R. C. Banks, Personnel Department.

SIKORSKY

Sikorsky Aircraft, one of the four divisions of United Aircraft Corporation, South Avenue, Bridgeport 1, Conn.

SAVANNAH RIVER PROJECT . . .

by Sandra Rains, E. Physics '57

In late 1950 the AEC (Atomic Energy Commission) first made public its plans for building the United States' largest nuclear energy installation. The plant, which was to be called the Savannah River Project, was to be constructed near Aiken South Carolina.

Temporary headquarters building of the Savannah River Project.

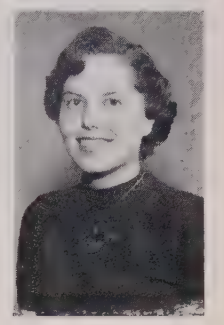
The site chosen for the project is in a rural part of South Carolina. A section of land twenty miles square containing approximately 315 square miles was bought by the government. The 6000 people who lived here were evacuated immediately. With the exception of the 800 people who lived in Ellenton and Dunbarton, all of the people had to leave farms which had been in their families for generations. This particular site was chosen because it met all technical and defense requirements, notably for space and seclusion.

Most of the land was heavily wooded and hilly, so the first job was to clear it. This was the initial step in the biggest construction job since the Panama Canal. In fact, this is the biggest industrial project ever undertaken from scratch.

The plant which was to be built here was not, presumably, to be a location for the manufacturing of hydrogen bombs. It is supposed to turn out the materials which can be utilized for bombs elsewhere. However, since the experimental explosion of a hydrogen bomb in Eniwetok last November, there has been little doubt in most peoples' minds that the principle business at SRP will be the manufacturing of hydrogen bombs. This will include the making of triple-weight hydrogen called tritium, which now has to be recreated since it no longer exists in nature. The AEC is being very careful to assure the people of the three counties involved in the SRP that they are in no danger. One hydrogen bomb could wipe out 300 square miles.

E. I. du Pont de Nemours & Company have the government contract for the plant. They started work January 11, 1951. In only the last few months has work progressed enough to be confidential. Now it is almost impossible to get inside the section. Credentials are checked at every stop, and there are many different projects scattered over the section which no one is allowed near. From a distance, all that can be seen are tall steel structures. The one building that can be entered is a starfish-shaped construction which is the temporary administration building. Cameras, field glasses, alcoholic beverages, and other things of this type are banned from the site. As work progresses further, the security veil will be drawn even tighter. The government remembers how our atomic secrets were stolen, and they do not mean for that to happen again.

The exact nature of the work at SRP is not known. The estimated total cost for the whole operation is $1,500,000,000. The only other information which has been disclosed is the amount of supplies which will be required to finish the project. They will use 75,000,000 board feet of lumber, 1,250,000 cubic yards of concrete, 85,000 tons of reinforcing steel, and 25,000 tons of structural steel. They are excavating 20,000,000 cubic yards of earth, drilling 60 drinking wells, stringing 95 miles of electric lines, laying 66 miles of railroad track, constructing 105 miles of new roads, and building 250 factory, laboratory, office, and other buildings. Six thousand, three hundred trucks and other vehicals are being used daily. After the plant is in operation, over a billion gallons of water a day will be taken from the Savannah River for use in some of the operations.



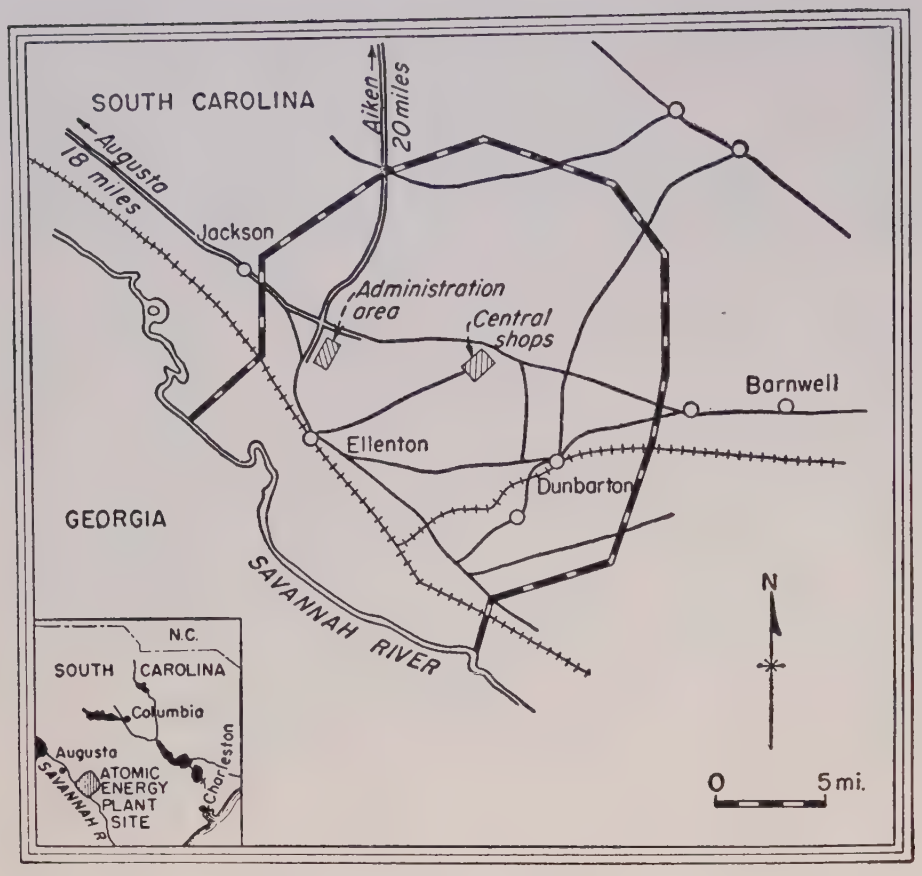
SANDRA RAINS. This is Sandra's first article for the Technograph. She is a freshman this year in Engineering Physics, and comes to the U. of I. from Hutsonville, Illinois. Sandra is quite interested in technical and plans to take journalism courses along with the standard engineering program.

The AEC owns all SRP lands and buildings and has control of the overall policies, but the construction, operation, and design of the project is left completely up to the Du Pont Company. Du Pont is handling most of the major portion of the work itself, but certain specialty jobs, such as highway and railroad construction, have been sub-contracted.

A small staff of AEC officials has been stationed at the project site to keep check on standards and costs. They also act as liason between the Du Pont Company and Government agencies. Their main job, however, is to see that the project progresses according to schedule.

Total employment for the construction of the plant has reached 45,000 men. After the plant is completed it will require a staff of 7,500 to maintain it. In September of 1953, the weekly payroll of all employees has reached $3,000,000, making the yearly payroll about $150,000,000. It is hoped that

Temporary worker housing for SRP construction crews.



Map of Savannah River Project.

after the plant is completed, the annual payroll will be $30,000,000.

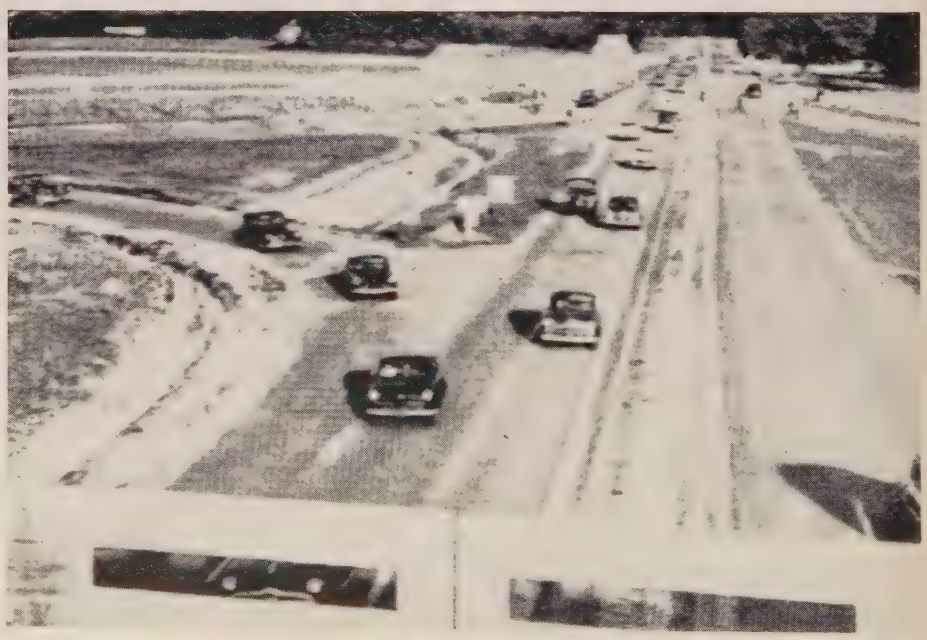
With the 45,000 men employed have come their families, so that over 120,000 people have invaded this small community in the last two years. About 30% of the people employed are from outside South Carolina and Georgia. The AEC decided it would be best not to establish a government town as they had at Oak Ridge, because the difficulties were thought to be disproportionally large in relation to the small part the towns played in furthuring atomic research. It was to be left to private enterprise in the Aiken-Augusta area to furnish food and lodging for the workers. As a result, this sleepy part of the country has been completely changed. The population has almost doubled, while the money in the local banks has increased by about one-third. Over 7,000 trailers dot the country side, and pre-fabricated houses spring up over night. Hotel reservations must be made at least ten days in advance. The schools and hospitals are becoming increasingly overcrowded, and the water and sewage systems have not proved capable of accommodating this huge increase in population. It is felt by a large number of people that it would have been wiser to have established a government town. They have asked the government for aid, and have received some help, but certainly not a sufficient amount. The AEC has tried to hire civic-minded people in their permanent staff, so in many ways the living conditions have been bettered.

There is only one large town near the site, and this is Atlanta, Georgia. However, they have not been largely affected by the plant due to the river separating them from South Carolina. There is no bridge in a place to make commuting satisfactory. Before the plans for the plant were announced, a bridge was being planned; but now the advisability of such a structure is being debated.

Work on the SRP is divided into two general phases; the construction of the factories and the operation of the plant after the manufacturing of atomic material starts. These two phases overlap considerably. The employment of the permanent staff was started in the middle of 1952 when construction employment was at its peak. Even after the main construction is finished and the plant is in operation, some construction will continue, meaning that there will be a permanent construction crew, as well as operating staff.

Although excellent wages and good working conditions have prevailed, the Du Pont Company has had much difficulty in hiring workers. Liberal training programs and a nine-hour day and a five-day week are offered. Also, a good safety program, one thing in which the Du Pont Company is outstanding, is in effect. Many people have not been hired because of health and security reasons, and racial discrimination has been another major problem. There has been a serious shortage of qualified engineers, skilled laborers, and clerical help.

The United States now has in their possession the largest hydrogen bomb plant in the world. Through the combined efforts of the Atomic Energy Commission and the Du Pont Company, promises to be one of the most successful ventures of modern times.



Part of the stream of workers' autos entering the project area during its construction phase.

Engineers Today — Executives Tomorrow

by Wilbert Stoecker

Clifford Strike, president of F. H. McGraw Company.

Thirty-five years after receiving his degree in electrical engineering from the University of Illinois, Clifford Hood became president of Carnegie-Illinois Steel Company and vice-president of operations of United States Steel Company.

Hood's slide rule now lies buried somewhere beneath inter-office communications, business statistics and reports. One out of every three of Hood's fellow graduates in engineering likewise has progressed to a position of management.

WILBERT STOECKER, M.S., is an instructor in the Mechanical Engineering Department.

Most of the courses that the engineer takes in college train him to be an engineer—not a manager whose concern is primarily with human problems. Looking forward to the time when he will sit behind a manager's desk, the student in engineering can begin his study of human relations by the choice he makes in his non-technical electives.

About thirty per cent of all engineers are in administration and management according to "Employment Outlook for Engineers," a 1948 bulletin of the United States Bureau of Labor Statistics. The percentages of some of the branches of engineering in administration are as follows: Chemical, 29.1; Electrical, 28.4; Mining, 41.6; and Mechanical, 32.0. Civil engineers have contributed the greatest percentage of supervisors with 47.5 percent in management. This percentage includes the 18 per cent of the civils who are supervising construction.

As if these figures are not impressive enough, the census-takers confessed that they had no way of knowing how many men, trained as engineers, listed themselves as vice-presidents, executives and managers.

More than four hundred of the top nine hundred executives in the country studied engineering or science in college, according to a 1952 survey made by *Fortune Magazine*. These men earn an average salary of $70,000 to $80,000 a year. *Fortune* says: "Many of the big companies have become too vast for a specialist in law or finance or engineering to manage. Men in these fields have reached the top. . . . because they possessed a broad view of the companies activities, and an ability to get along with people."

It took Clifford Strike just seven years after he was graduated from the University of Illinois in mechanical engineering to become vice-president of a construction company. Today, Strike is president of F. H. McGraw Company, international constructors and engineers. His company handles some of the largest construction projects in the world. Because each company has only about one president, all engineers can't be presidents like Strike and Hood. But there are many administrative jobs at all levels, such as project leaders and foremen, which require some of the same qualities needed by the president and vice-presidents.

In each succeeding year after a class graduates, more and more of its engineers join the supervisory ranks. Engineering graduates of the University of California reported that the longer they have been out of school, the greater is the likelihood that they are administrators. Table I shows this progressive increase in administrators.

TABLE I

Years from Graduation	Percent in Administration *Mech. Engr.*	*Mining & Met. Engr.*
0-5	2	1
5-10	7	7
10-15	19	19
15-20	34	25

Almost all of the engineers who are in administration supervise technical activities, reports the Bureau of Labor Statistics. No doubt these men hold administrative positions primarily because they have had technical training. Nevertheless, their chief concern gradually becomes *people,* rather than things. These engineers - turned - administrators must now get things done—not by doing the work themselves, but by having others do it.

What can the engineering student do while in college to prepare himself for possible managerial duties? He can choose his electives from the humanities and social sciences, and thus he can increase his consciousness of human nature.

A knowledge of human problems is a must for managers, according to Clarence Randall, chairman of Inland Steel Company. He says, "To be worthy of management responsibility today, a man must have insight into the human heart, for unless he has an awareness of human problems, a sensitivity toward the hopes

Clifford Hood, Electrical Engineering, 1915.

and aspirations of those whom he supervises, and a capacity of anlysis of the emotional forces which motivate their conduct, the projects entrusted to him will not get ahead no matter how often wages are raised."

The social sciences offer an excellent opportunity for a systematic study of human beings and their emotions. Sociology is the study of group behavior, whereas psychology concerns itself primarily with the individual. A good course in history will necessarily examine the behavior of groups as well as individuals. You cannot study history without realizing that social changes are always taking place. Thus you become alerted to shifts in moral and social standards that are going on around you.

Literature courses can be beneficial electives. Often literature is good because the author has a keen insight into human nature. A good author can capture the spirit of his time, and the book becomes popular because it expresses the sentiments of a large body of readers. The arts have their place in stimulating a richer enjoyment of life, but they are not ordinarily an aid in professional advancement.

Within the College of Engineering there are several courses, officially classified as non-technical electives, which study human relations in industrial situations. These courses deal with the operation of a company and the supervision of its workers.

In several of the engineering curriculums at Illinois, the stuent can choose between a technical or a non-technical elective. Probably those who would profit most from an L.A.S. course prefer to stay on familiar, technical ground. Even when a non-technical course is prescribed, some students take an L.A.S. course in a physical science for fear that any subject which does not involve mathematics will poison the mind.

You need not expect any miracles to happen after you have taken several courses in the social sciences. These courses are but a step in heightening your awareness of human problems and emotions.

Many well-meaning people have said that engineers should solve human problems with the same logical approach that they use in engineering. The fact is that the ability to analyze the stresses in a column or beam does no necessarily equip an engineer to settle a thorny dispute in his plant. Human beings will often be controlled by prejudices and sentiments; therefore, the engineer must always be conscious of the emotions of the people with whom he works.

"Now then, Johnny," said the teacher, "I want to give you a little problem. Suppose there were five children and their mother had only four potatoes to share between them. She wants to give each child an equal share. How would she do it?"

"Mash 'em," said the boy.

* * *

"I was so cold last night I couldn't sleep."

"And did your teeth chatter?"

"I don't know. We don't sleep together."

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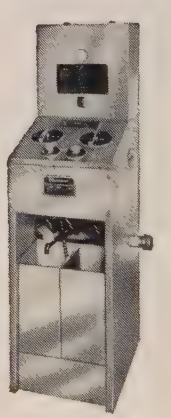

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75 Years of Progress in Pure Water
1878 1953
Barnstead STILL & STERILIZER CO.

THIS NEW FLASH POINT TESTING MACHINE is so accurate that a sample with as little as 1/10 of 1% unsafe material in it will cause a rejection. Recently developed by Standard Oil's Engineering Research Department, this revolutionary device reduces the average time from 20 minutes for a flash test to two and a half minutes, avoids human errors in testing flash point, can be used right at the loading rack.

Adventures in Research

The flash point testing problem that was solved with the machine shown above is only one of the many problems presented to Standard Oil's new and growing Engineering Research Department.

In the last few years, it has developed and put into operation instruments to measure vapor pressure, 158° point, acidity and viscosity. Ultrasonic generators have been built for general use in providing energy for experimental purposes. The department is studying application of radioactive isotopes to instrumentation and control problems related to refinery operation.

One of our research divisions is carrying out an extensive theoretical study of stresses in pressure vessels having flat, conical, hemispherical, toriconical or torispherical heads.

In our work on product evaluation, we have developed a new test for quenching oils based on the fundamental heat transfer relationships involved.

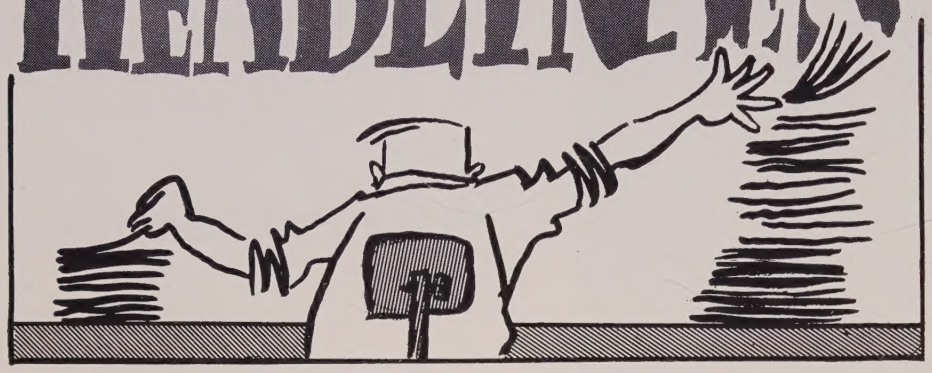
Problems such as these are the daily fare of Standard Oil's Engineering Research Department. Here is a challenging opportunity for young men with advanced training in chemistry and engineering. Many and varied problems continually arise in the design, construction and operation of petroleum industry equipment.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

SKIMMING INDUSTRIAL HEADLINES



by Chuck Foley, M.E. '55

Ball Bearing Retainers

Precision bearings capable of attaining speeds in excess of 100,000 rpm are now possible through the use of thermosetting laminated plastics. As manufactured and fabricated by Synthane Corporation of Pennsylvania, retainers for machine tools, grinding spindles, turbine and supercharger blowers, and aircraft instruments can be machined within the tolerances required for precision and super-precision bearings.

The comparative light weight of laminated plastics provide bearing designers with a number of advantages over metals. Due to the smaller masses involved, centrifugal forces resulting from extremely high speeds are reduced, and as a consequence, there is less friction and wear against adjacent metal surfaces. Laminates, while virtually impervious to oils and greases, do absorb small quantities of lubricant during machining, and therefore, the bearing has self-lubricating characteristics.

Electron Toughened Containers

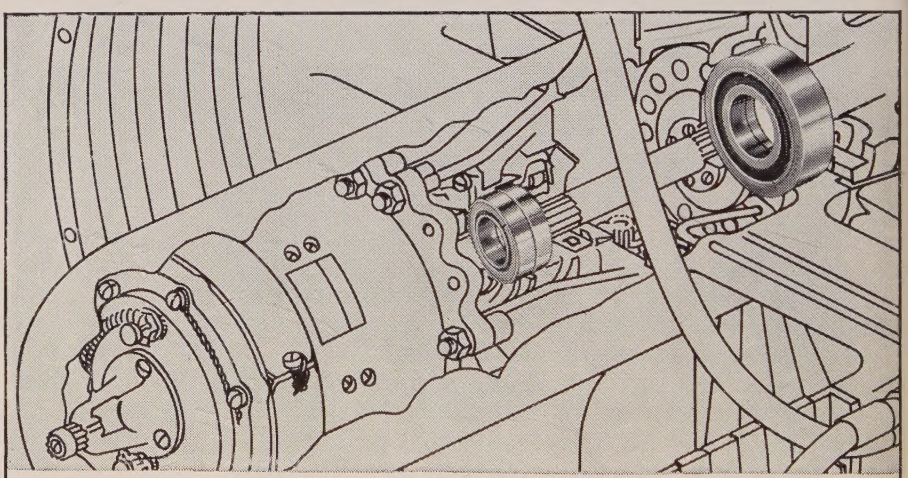
The electron, already one of man's most versatile servants, now can toughen flexible plastic containers to withstand steam and can prevent certain plastic dishes from wilting in the hottest automatic dishwasher. Dr. C. G. Suits, G-E vice president and director of research, has stated.

The newly found method for "curing" plastics cross-links long, chain-like molecules called poylmers which make up these plastics. A few second's bombardment with electrons from a million-volt X-ray machine makes polythelene bottles stand up under steam-sterilization. This toughening permits more widespread use of these containers for packaging and storing pharmaceuticals and biological fluids. The latter include blood splasma, which formerly could be carried only in bulky, easily sterilized glass.

Pint-Sized Atom Pile

A pint-sized atomic pile, "little brother" to the big ones used to make plutonium for atomic bombs, has been placed in operation as a research tool at the Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the General Electric Company for the Atomic Energy Commission.

The new low-power nuclear reactor, in contrast to huge reactors at the company's Hanford Works, Richland,



Turning Points in Jet Engine Design

Designing more power into less space . . . a trend in jet engine development . . . puts a premium on space-weight saving factors as well as performance. That's one reason why jet engine designers are specifying more and more Fafnir Ball Bearings for every important turning point from main rotor to accessories and gear boxes. Fafnir Ball Bearings save space and weight as well as meet performance requirements established for the latest type jet engines. By keeping in step with aircraft progress, Fafnir continues to lead in the production of aircraft bearings. The Fafnir Bearing Company, New Britain, Conn.

AVAILABLE

A sound-motion picture depicting high points in the manufacture and use of Fafnir Ball Bearings is available to engineering classes. Write to The Fafnir Bearing Company, New Britain, Conn., for details.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

Wash., is contained in a cube of graphite measuring only five feet on a side.

While a low-energy reactor of this sort cannot be used for making plutonium, or for the production of atomic power, it is a useful source of the atomic particles called neutrons, which can be utilized in many fields of fundamental research.

Indoor Electrical Highway

Electronically-controlled dynamometers provide an indoor highway for automotive testing at the Ford Motor Company's new Research and Development Center, Dearborn, Michigan. The dynamometers were built by Westinghouse Electric Corporation.

The ability of these dynamometers and their associated equipment to simulate many road conditions, such as inertia, wind resistance, and road grades, has made it possible to move automotive proving grounds indoors for many tests.

New Hot Strip Mill

A new 66-inch semi-continuous hot strip mill, one of the fastest of its type in the world, has begun operation at the Allenport, Pa., Works of the Pittsburgh Steel Company.

The hot strip mill is part of a $62,300,000 expansion program designed to place the company in the flat-rolled products market. Pittsburgh Steel in the past has been known primarily as a producer of ingots, seamless-tube, and wire products.

The new mill, using four finishing stands, has a rated top speed of 1770 feet per minute and is expected to produce 600,000 tons of strip and sheet steel annually. Provisions have been made to accommodate two additional finishing stands in the future which will raise the mill's speed to 2230 feet per minute.

Rubber Tired Railroad

A rubber tired locomotive and freight car combination dubbed and capable of economic operation over pathless desert sands or cheaply constructed roads has been unveiled by the R. G. LeTourneau of Longview, Texas.

The heart of the Tournatrain is an "electric wheel," which carries a large pneumatic tire and has within its rim an electric motor and gear reduction. These electric wheels are being built in different sizes to take tires from 5 to 10 feet in diameter.

Every wheel of the Tournatrain is a rubber tired, self propelled electric wheel. The electric wheels derive their energy from the locomotive which mounts diesel engine driven electric generators. The Tournatrain engineer, from his cab on the locomotive, applies power at will to all wheels of the Tournatrain. In this way each freight car provides propulsion for its own load—each car of the Tournatrain pushes and pulls at the same time. There are no brake shoes to wear out because the same electricity that drives the wheel can be used to hold it back going down hill. Only an automatic spring loaded brake is provided for emergency.

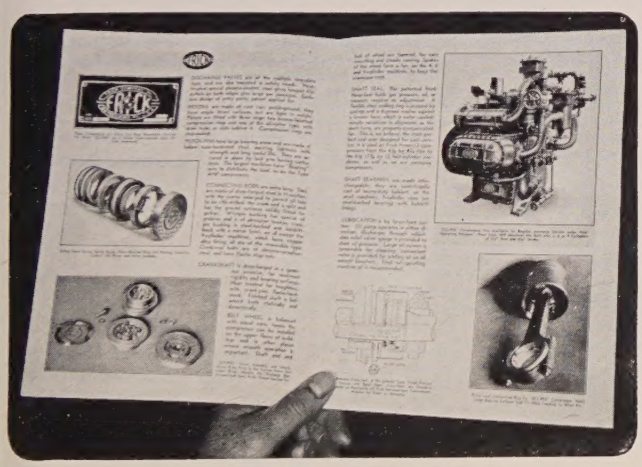
Each car is coupled to the car ahead of it in such a way that it follows in the same tracks. By a simple automatic steering device the path of the locomotive is duplicated in its turn by each of the train so that the locomotive can pull up to a street intersecion and make a right angle turn and every car will come up to the same spot and make the same turn.

Higgins: I don't blame you for being sore at McTavish for running off with your wife."

Biggins: "It isn't that. It is the idea that the old skinflint had to wait until I bought her a set of new false teeth."

* * *

Small boy explaining broken window to policeman: "I was cleaning my slingshot and it went off."



Interested in Refrigeration or Air Conditioning?

Then you should see this new Bulletin on Frick "ECLIPSE" compressors . . . the world's finest line of commercial and industrial refrigerating machines. Full range of sizes—from two to nine interchangeable cylinders . . . for use with all standard refrigerants. Maintain any temperature from 140 degrees below zero to 80 degrees above. Over 70 years' experience built into them. Write today on your firm's letterhead for Bulletin 100-F.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

Here's another new aid to precision production from Brown & Sharpe—enables you to specify closer tolerances and know they're practical. This new No. 955 Electronic Caliper permits production gaging in units from .0001" to .00001", often without removing work from machine or fixture . . . or without lifting work from the bench. Readings are taken on the No. 950 Electronic Amplifier. Four interchangeable jaws provide a measuring range from 0" to 4" . . . only one master needed for each setting. Aligning attachment also available to facilitate measuring long work pieces. Write for the new illustrated Bulletin. Brown & Sharpe Mfg. Co., Providence 1, Rhode Island, U. S. A.

Brown & Sharpe B·S

"Allis-Chalmers Graduate Training Course Helped Me Find the Work I Like"

says HUGH C. SELLS,
Syracuse University, BS—1942
and now Manager, Knoxville District Office

"I guess I was like many graduating engineers. I didn't really know what I wanted to do. When the Allis-Chalmers representative visited the campus, and described their Graduate Training Course, it sounded like the type of postgraduate training I really needed.

"What appealed to me then—and still does—is the broadness of the program. Here is a company filling a unique spot in industry. It makes important, specialized equipment for almost any industry you can name."

Wide Choice of Activity

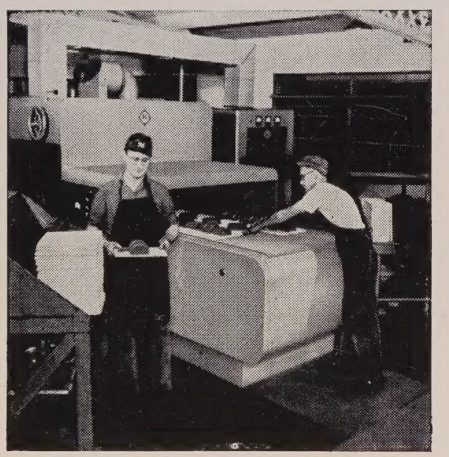
"It's like a big department store for industry. But that isn't all! In addition, it offers a wide choice of activity within each of these many product groups . . . whether it be sales, design, research or production.

"After getting the broad look at industry the program offers, my interest began centering on Service and Erection of large equipment. This led me into many departments of the company, and I learned about everything from steam turbines to sifters for flour mills."

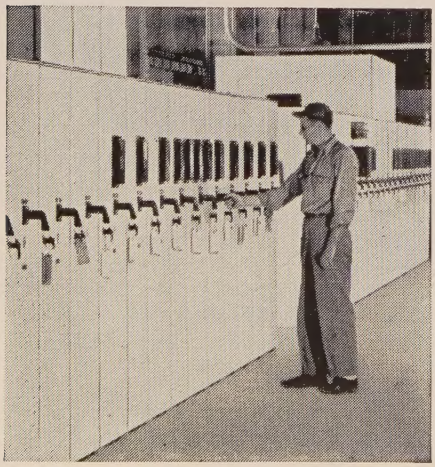
Valuable Background

"The transition from service to sales was natural. The background of service and erection work proved very valuable.

"So you see, whether you think you know what you want to do or not, the Allis-Chalmers Graduate Training Course is so flexible, so broad in its scope, you have a real chance to find yourself. Best of all, you don't have to waste time doing it."



ELECTRONICS—Modern way to dry sand cores is with Allis-Chalmers *Foundromatic* Sand Core dryer. Revolutionary new process dries cores in minutes instead of hours.



POWER—Neat, compact and safe switchgear installation is big improvement over open framework and knife switches in older installations.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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